AUTOMOTIVE INDUSTRIES
The Automobile

Reg. U. S. Pat. Off.
Published Weekly

Volume 78 — Number 14

Contents

C. A. MUSSELMAN, Pres.; J. S. HILDRETH, Vice-Pres. and Manager, Automotive Division; G. C. BUZBY, Vice-Pres.

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AUTOMOTIVE INDUSTRIES

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April 2, 1938
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Production

. . . industry misses 700,000 first quarter mark as seasonal spurt fails to materialize.

March of this year will go down in automotive history as a month in which the usual seasonal spurt in retail sales failed to materialize sufficiently to encourage a comparable rise in factory production schedules.

During the final week of the month estimated production hovered around a mark of 50,000 units which represents a small drop from the previous week and brings the revised estimate of the total output of cars and trucks for the month to less than 250,000 units.

On this basis the industry will have finished the first quarter of 1938 with an output of less than 700,000 and final figures probably will show the first quarter total to be nearer 675,000 units which represents a 48 per cent drop from the 1,302,509 cars and trucks produced during the same period a year ago.

Normally March sales and likewise production have always shown a gain over February. During the past 10 years this gain has averaged 27 per cent although it has varied from a low of four per cent to a high of more than 50 per cent. March will show a gain over February this year but almost entirely because shortened schedules and the calendar gave the

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Labor

Strike violence returns to Detroit with flare-up at Federal Screw Works.

Clashes between police and union pickets on two consecutive days marked the return of violence to the Detroit area labor situation after international officials of the United Automobile Workers had authorized a strike against the Federal Screw Works in Detroit in protest against a reduction in pay of 10 cents an hour, and cancellation of its agreement.

Prior to calling of the strike Frank M. Edgar, president of the company, had announced that his firm was confronted with two alternatives: either to move the plant to another location because of business lost to competition from out-of-state manufacturers enjoying appreciably lower wage rates, or by asking the present employes to accept reduced wages to permit the company to maintain its competitive position.

The clashes occurred when police escorted workers through picket lines around the plant which normally employs 300 hands. Union officials claim that the company rejected offers to accept a five cent cut as a loan repayable in a year or a

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GM-Bendix

D. O. Thomas and E. R. Palmer of General Motors Corp. made vice-presidents of Bendix Aviation Corp.

David O. Thomas, general manager of the Saginaw Malleable Iron Division of General Motors at Saginaw, Mich., has relinquished his duties to become vice-president of the Bendix Aviation Corp., South Bend, Indiana, according to an announcement made by General Motors Corp. on Wednesday.

William H. Doerfner, works manager of the Saginaw Malleable Iron Division, succeeds Mr. Thomas as general manager. The changes are effective April 1, 1938. James H. Smith succeeds Mr. Doerfner as works manager.

Coincident with the announcement concerning Mr. Thomas, it was announced that Edwin R. Palmer, assistant comptroller of General Motors, has been elected a vice-president of the Bendix Aviation Corp., effective April 1.

Mr. Thomas has been in charge of the Saginaw Malleable Iron Division since 1930, and his service with General Motors dates back to 1912. His work with GM has included important manufacturing and foundry assignments in Muncie, Indiana, Detroit and Saginaw, Michigan.

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DAVID O. THOMAS

. . . has been named vice-president of the Bendix Aviation Corp. Mr. Thomas was formerly general manager of the Saginaw Malleable Iron Division of General Motors. William H. Doerfner, works manager of the Saginaw Malleable Iron Division, succeeds Mr. Thomas. (For additional details see article on this page "GM-Bendix.")

EDWIN R. PALMER

. . . also has been made a vice-president of the Bendix Aviation Corp. Mr. Palmer was formerly assistant comptroller of General Motors. (For additional details see article on this page "GM-Bendix.")

Behind the Output Minus Sign . . . 49.5 Per Cent

Plus movements registered in passenger car production appeared in three wholesale price classifications during the first two months in 1938 as compared with the similar period last year, although the overall picture is bluntly expressed by 49.5 per cent behind a minus sign.

As was the case also in last month's statistical table, the biggest per cent advance is noted in the group "$3,001 and over," while the largest volume increase is found in the classification "$751-$1,000." A plus 79.2 per cent change was marked up for the latter; plus 16.1 for "$1,001—$1,500."

In the table "Truck Production by Capacities," there is only one plus registered—a 9.4 per cent change for "Special trucks and buses." For January the per cent change number for this classification stood at minus 13.5.

Passenger Car Production by Wholesale Price Classes
(U. S. and Canada)

	Two Months		Per Cent Change	Per Cent of Total	
	1938	1937		1938	1937
Under $750	282,686	610,474	−53.6	88.14	96.11
$751-$1000	31,968	17,816	+79.2	9.97	2.80
$1001-$1500	4,839	4,164	+16.1	1.50	.66
$1501-$2000	722	2,097	−65.5	.23	.33
$2001-$3000	404	554	−27.0	.13	.09
$3001 and over	100	47	+113.0	.03	.01
Total	320,719	635,152	−49.5	100.00	100.00

Truck Production by Capacities
(U. S. and Canada)

	Two Months		Per Cent Change	Per Cent of Total	
	1938	1937		1938	1937
1½ Tons and less	103,919	139,155	−25.5	94.56	94.07
2 to 3 Tons	2,899	5,508	−47.2	2.64	3.72
3½ Tons and over	1,528	1,854	−17.6	1.39	1.25
Special and buses	1,550	1,417	+ 9.4	1.41	.96
Total	109,896	147,934	−25.8	100.00	100.00

For Peace In Akron

Business Men Offer Plan to Ease Goodrich-URW Snarl

A group of Akron business men under the leadership of Akron City Councilman Robert C. Ryder, have submitted to the B. F. Goodrich Co., the United Rubber Workers of the CIO, the Department of Labor and the National Labor Relations Board a plan of guaranteed employment for the Goodrich company and its employes. Recently Goodrich declared that unless labor accepted substantial wage cuts, it would have to transfer 5000 jobs to other cities. The URW was scheduled to vote on the issue when orders from the Department of Labor caused indefinite postponement of the vote. Much opposition to a URW member referendum had arisen, with Akron leaders arguing the employe referendum should be plant-wide. The Department of Labor and National Labor Relations Board immediately sent fact-finding commissions to Akron to study the situation.

The guaranteed employment plan as proposed includes: 1. A guarantee of 42 weeks' work a year to be given to 8000 employes; 2. These 8000 persons to be guaranteed average weekly wages of $20 to $35 a week, depending on their particular work; 3. After payment of all fixed charges, including dividends on preferred stock and plant depreciation, the net profits be divided, with 80 per cent to holders of common stock and 20 per cent to the 8000 guaranteed employes.

"The advantages of a great industry and its factory employes working together in harmony for their own mutual benefit and profit is a goal worthy of the most serious and sincere consideration," declared Ryder.

Goodrich now has 9500 employes in Akron. It has subsidiary tire and mechanical goods plants in California, Canada, at Cadillac, Mich., and in Oaks, Pa.

The wage reductions proposed by Goodrich were: A cut from present wage averages of $1.10 per day to 90 cents for men, and from 70 and 75 cents an hour to 60 and 65 cents an hour for women.

Wheel Tractor Exports Gain 93% in February

Exports of wheel tractors during February were valued at $2,675,886 compared with $1,387,620 during February a year ago, according to the Machinery Division, Department of Commerce. Sales were almost double last year in the 15-32 belt horsepower sizes, $1,624,324 against $840,730, and more than double in the 33 and over horsepower sizes, $974,154 against $417,137. Reduced shipments were made of the sizes under 14 horsepower, $77,403 compared with $129,753 in February, 1937.

Foreign sales of tracklaying tractors in February amounted to $1,629,160, a 20 per cent increase over the February, 1937, shipments valued at $1,365,569. Most of this gain was registered in the carburetor type, the exports of which totaled $763,936, an increase of 48 per cent over the February, 1937, foreign business valued at $514,073. As usual, most of the carburetor type sales were made in the sizes under 35 drawbar horsepower. The export business in the fuel injection type was only 2 per cent greater than a year ago, $865,224 compared with $851,496. Greater sales were made in the sizes under 35 drawbar horsepower, $148,150 against $28,557, smaller sales in the 35-59 horsepower sizes, $333,100 against $483,224, and larger shipments in the 60 and over horsepower sizes, $383,974 against $339,715. The exports of tractor parts and accessories were valued at $723,223 compared with $465,536 in February, 1937.

. . . slants

REPOSSESSIONS — *More than a fourth of repossessions of instalment sales of automobiles are made before the buyer makes his first payment. This is revealed in a survey that has just been completed by Milan V. Ayres, analyst and statistician of the National Association of Sales Finance Companies. The actual percentage is* 26.5.

The study was made from the records of one of the largest companies covering repossessions in 1936 *and the first half of* 1937. *It covers* 1007 *repossessions of both new and used cars.*

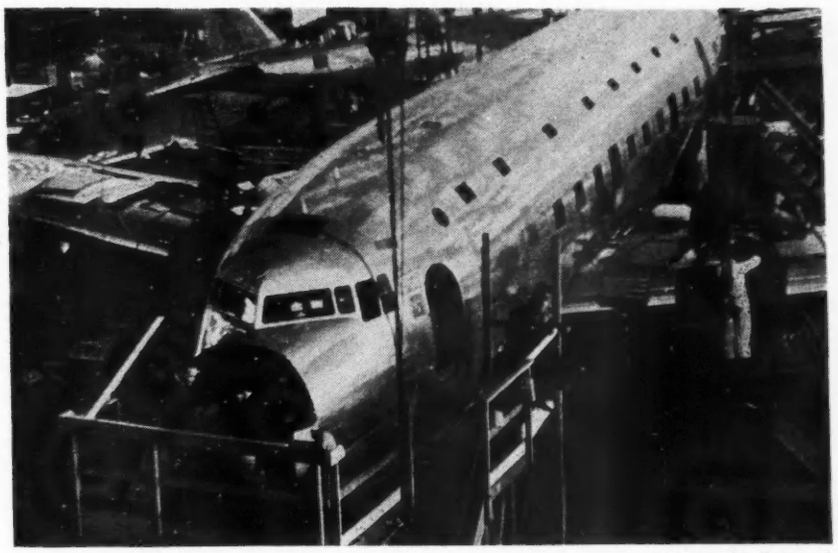
Percentage of cars repossessed de-

creased rapidly with the number of instalment payments made. Only 0.1 *per cent—or, actually, one car—was repossessed after* 12 *payments had been made.*

No attempt was made in the study to separate new and used cars, but it is accepted that the larger number of repossessions were used cars.

BOOSTS BUYING—*Railroad expenditures for automotive equipment and supplies for 1937 totaled $5,087,000 compared with $3,915,000 in 1936, according to the Association of American Railroads.*

RUBBER SPRINGS—*According to Dr. Warren F. Busse, director of the physical research laboratory of The B. F. Goodrich Co., rubber springs for automobiles are now practical. Speaking to members of the American Institute of Physics at Ann Arbor, Mich., Dr. Busse reported, "A very simple method now being tried is to use rubber springs in torsion. . . . These torsion springs can be 'wound up' to support high loads, and yet have a soft load-deflection curve. The small amount of 'creep,' or elastic after-effect that may develop after a few years service can be easily compensated for by various means such as a slight increase in the initial twist given the springs." He added, "The problem of replacing steel springs with rubber in the automobile involves developing a mechanical construction which will magnify the distortions of the rubber so that it will carry high loads."*



Underwood & Underwood

"SILVER SKY QUEEN" New 42-passenger airliner under construction at Santa Monica, Calif., for the five largest airlines in the United States. It is reported that it will cost $1,500,000.

Australian '37 Truck Sales Highest in History

Automobile sales in Australia during 1937 reflected the healthiest condition in the automotive market of that country since 1928 and 1929, while sales of commercial vehicles were the highest ever recorded, according to statistics made available in Australia and reported to the Department of Commerce from the office of the American Commercial Attache at Sydney. Total sales of new passenger cars and commercial vehicles in Australia during 1937 amounted to 80,711 units valued at approximately $145,000,000.

New passenger car sales during the year amounted to 58,063 units, a gain of approximately 19 per cent compared with the 48,793 passenger units sold during 1936. New commercial vehicle sales in Australia during the year totaled 22,648.

Imports of automotive units into Australia from the United Kingdom, the first ranking foreign source of supply, during the first 11 months totaled 23,385 units valued at approximately $11,625,500. The United States, which accounted for 23,884 units valued at approximately $9,689,000, ranked second in point of value but third in point of quantity. Imports from Canada amounting to 28,775 units valued at approximately $8,407,000 ranked third from the standpoint of value but above both the United Kingdom and the United States in point of quantity.

February's Total Output Sagged 47 Per Cent

February, 1938, total passenger car and truck production sagged 47 per cent below the February, 1937, figure of 383,900 units and also tapered off 11 per cent from the output in January this year. Total production for the first two months of the current year compared to the similar period in 1937 dropped 45 per cent.

Passenger Car and Truck Production
(U. S. and Canada)

	February 1938	January 1938	February 1937	Two Months 1938	Two Months 1937
Passenger Cars—U. S. and Canada					
Domestic Market—U. S.	120,035	130,830	276,469	250,865	562,218
Foreign Market—U. S.	19,484	25,232	20,319	44,716	44,064
Canada	11,753	13,385	14,173	25,138	28,870
Total	151,272	169,447	310,961	320,719	635,152
Trucks—U. S. and Canada					
Domestic Market—U. S.	32,458	35,530	53,765	67,988	107,639
Foreign Market—U. S.	14,829	18,528	13,640	33,357	29,875
Canada	4,313	4,239	5,534	8,552	10,420
Total	51,600	58,297	72,939	109,897	147,934
Total—Domestic Market—U. S.	152,493	166,360	330,234	318,853	669,857
Total—Foreign Market—U. S.	34,313	43,760	33,959	78,073	73,939
Total—Canada	16,066	17,624	19,707	33,690	39,290
Total—Cars and Trucks—U. S. and Canada	202,872	227,744	383,900	430,616	783,086

China's 1937 Imports Lifted 20 Per Cent

Imports of motor vehicles into China during 1937 totaled 6166 units compared with 5148 units during the preceding year, the largest annual importation of motor vehicles into that country since 1934, according to a report to the Automotive-Aeronautics Division, Department of Commerce, from the office of the American Commercial Attache at Shanghai.

Of the total imports of motor vehicles into China during 1937, the United States supplied 80 per cent, with Germany ranking in second position with 14 per cent.

The SAE Heard Them Speak On Passenger Cars . . . and Politics

E. H. Smith
Asst. Chief Engr., Packard

C. E. Bleicher
Vice-President and General Manager, DeSoto

R. N. Janeway
Head, Dynamics Res. Dept., Chrysler

Jos. Ledwinka
Chief Engineer, E. G. Budd

Alex Taub
Power Unit Engr., Vauxhall

C. R. Paton
Chief Engr., Packard

John Oswald
Engr., Charge of Body Design, Oldsmobile

Left to Right:

G. L. McCain
Res. Engr., Chrysler

R. W. Brown
Mgr., Air Springs Dept., Firestone

W. R. Griswold
Engr., Charge of Design Analysis, Packard

Left to Right:

S. O. White
Chief Engr., Warner Gear

Tore Franzen
Exper. Engr., Chrysler

Gen. H. S. Johnson

"Missing Element Is Confidence"

Gen. Johnson Tells SAE Banqueteers at Detroit Convention; Society's Council Plans World Automotive Congress

Gen. Hugh S. Johnson, featured speaker at the SAE banquet held at the Hotel Statler, Detroit, on March 29, blamed government for the country's current difficulties. Six hundred persons attended the banquet which closed the society's first National Passenger Car Activity convention.

"The trouble is government," Johnson said, "and the missing element is confidence. The government threatens and bulldozes the very economic system upon which it depends for revenue. If the budget is balanced by economy the outlook for business is excellent. If the Government keeps on as it has been going, what is the outlook for business? There ain't none."

He prophesied that the Government Reorganization bill faces a critical fight in the House and assured the engineers that it still can be defeated, urging them to bombard Representatives with telegrams and letters expressing opposition to the legislation.

"The most heartening present sign is the tax bill. I know that Senator Harrison will report back a bill that reflects the best accounting and business experience. The capital gains and undistributed profits taxes, if not completely eliminated, will be so emasculated that nobody can much complain."

First technical session of the convention was opened by John A. C. Warner with the observation that this meeting, the first of its kind, already had paved the way to new SAE activities. One of its fruits is the decision of the SAE Council to stage a World Automotive Congress in 1939 as a definite project.

The first session with R. N. Janeway in the chair comprised two papers—"Motor Car Engines in England" by Alex Taub, which was read by S. W. Sparrow, and "Fundamental Investigation of Supercharging" by Richard Sneed, Ethyl Gasoline Corp. Viewed as a critical analysis of British design through the eyes of a prominent American automotive engineer, Taub's paper aroused a great deal of favorable comment and discussion. F. F. Kishline and S. W. Sparrow both complimented Taub on the excellence of the paper but Sparrow and Macey Teetor disagreed with the conclusion that the unequal distribution of wear was caused by too low jacket water temperature. It was suggested that the wear may have been caused by too high temperature due to localized hot spots. Both agreed that the desirable condition is one of uniform cylinder wall temperature and not too high in value. Max Roensch found an invaluable contribution in Taub's comments on the crankcase lube situation in England since the use of high viscosity lubes explained the starting troubles that have always been experienced even with American cars used in England.

Second session comprised two papers — "Transmission and Control Developments" by S. O. White, chief engineer, Warner Gear Div., and "Car Cost Control" by C. E. Bleicher. Discussion of White's pa-

per elicited most spirited debate concerning the desirability and virtues of automatic transmissions, leaving the situation more or less in status quo. While factory engineers sided with A. G. Herreshoff, of Chrysler, in the opinion that driver habits made it inadvisable to introduce a novel mechanism, the proponents led by O. E. Banker made a very strong case for the adoption of a practical and commercial automatic transmission. Banker offered published statistics showing the service history of the automatic transmissions installed on the double-deck city buses in Chicago and New York City as evidence of the practicability and serviceability of the Banker unit. To date, about 500 new buses equipped with the Banker transmission have rolled up about 20,000,000 road miles.

H. T. Woolson, Chrysler executive engineer, advised an open-minded attitude since it was so easy for the engineer to stick to old habits and accustomed trends. Herreshoff gave unqualified approval of the overdrive unit with automatic features but felt that Chrysler would be opposed to any full automatic transmission of the step type.

C. E. Bleicher's paper may best be summarized as an excellent discussion of what may be accomplished by complete cooperation between the engineers and the production department. Establishment of maximum cost levels originates with the sales department, in Bleicher's opinion, and the various details of design and manufacturing procedures must be worked out cooperatively in conjunction with the cost department if the success of a given program is to be assured. Bleicher estimated that in general the cost of materials represents about 65 per cent of the total cost while labor is about 15 per cent of total cost. An interesting and instructive point made in the paper is that the parts makers should adopt, where possible, the control methods current among passenger car builders and thus make it easier for suppliers and users to get together on prices.

Best attended session of the meeting was the third session dealing with car suspension and ride. It comprised three papers — "Riding Comfort Requirements" by R. W. Brown, Firestone Tire & Rubber Co.; "Recent Developments in Design of Passenger Vehicle Suspension Springs" by Tore Franzen, and "Notes on Ride Controls and Calibration" by C. R. Paton. In commenting on Tore Franzen's paper, a number of engineers representing leading leaf spring producers pointed out that the leaf spring construction for independently sprung jobs involves a large saving in material cost as compared with the coil springs currently used. One figure indicated that the cost of the leaf spring was about 88 per cent of the cost of a coil spring. It was intimated that the coil spring adoption was dictated by the reluctance of designing engineers to make room for the longer front springs required for a soft suspension.

Final session contained one paper —"Body and Chassis Development," a discussion of the so-called unitary construction of combined body and frame unit, by Joseph Ledwinka, Budd chief engineer. This paper brought out a great deal of discussion and again showed a division of opinion on the fundamental issue. Some engineers went along with John Oswald, chairman of the session, in questioning the desirability of adopting unitary construction when so much more development still is possible in the conventional practice. Moreover, he questioned whether it would be possible to produce a commercial product within the same cost range as the conventional body and frame assemblies. Tore Franzen noted that the use of the unitary construction would introduce fresh and difficult problems with respect to independent front end suspensions.

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

High or Low Build?

"In one of the electric vehicles at the Exhibition the seat is considerably higher than usual in motor vehicles. The manufacturer said in explanation that his customer ordered it so, and he followed instruction though he did not approve of the high seat.

"The public who have never had experience with motor vehicles nor thought much on the problems involved, will prefer the high seat at first from mere force of habit, because horse vehicles are uniformly so constructed, but a little experience will convince any one of the desirability of the low build for ordinary purposes, on account of ease of ingress and egress, the greater actual safety and the pleasant feeling of security even at high speeds."

From *The Horseless Age*, 1898.

Financial Notes

Reports From Bendix Aviation, Motor Products, Spicer, City Auto, and Reo

Gross volume of business increased during 1937 over 1936 for the Bendix Aviation Corp., but due to increased labor and material costs in the early part of the year the profit margin was reduced. The corporation showed a net income of $2,255,133.33 for 1937 compared with $3,025,499 for 1936, according to the annual report released by Vincent Bendix, president.

The income reported is net after all taxes, amounting to approximately $1,491,000 and experimental, development and patent expense amounting to $1,800,927 have been charged off.

Dividends paid during the year amounted to $2,097,608. Current liabilities of the corporation total $3,919,123, which makes ratio of current assets to current liabilities of 4.23 to 1 as of Dec. 31, 1937.

Motor Products Corp. in its annual statement for the year ending Dec. 31, 1937, reports an increase in volume of business over the previous year, sales showing an upward swing of approximately 16 per cent. Profits, after deductions of all expenses, were $2,147,130.52, or $5.49 per share. Dividends declared during the year totaled $5 per share. This corporation's expenditures for plant additions aggregated approximately $230,000.

Spicer Mfg. Corp. has declared a quarterly dividend of 75 cents on preference stock payable April 15 to shareholders of record April 5.

City Auto Stamping Co. in its annual report shows a net profit of $392,771, which equals $1.05 per share on 375,000 shares outstanding for 1937. The company paid 90 cents a share in dividends. Plant improvements cost $307,596 for the year. The company closed 1937 with $1,073,994 current assets and $111,881 current liabilities.

Report of the Reo Motor Car Co. for the year ended Dec. 31, 1937, shows net loss of $1,982,293 after taxes, depreciation, and amortization of $522,915, inventory and other charges of $883,244.

February Tire Exports Slumped 23.1 Per Cent

The Commerce Department has reported that February exports of truck and bus casings, numbering 15,536 tires valued at $301,099, slumped 23.1 per cent in volume under January exports. About 36,000 inner tubes, valued at $55,460, were exported in February, a decrease of 37.8 per cent in volume under the previous month.

Exportation of fan belts declined 23.5 per cent compared with January, the department said, and the volume of autocloth exports was 60.4 per cent less than the previous month.

AUTOMOTIVE ABSTRACTS

Aircraft Controls

A long illustrated article on Aircraft Controls by J. Bally appears in *Revue de l'Aluminum*. It covers mechanical, hydraulic, pneumatic, hydro-pneumatic and electrical controls.

On the majority of airplanes a variety of control systems are used. Use of a single system would not take sufficient account of the diversity of problems encountered and might be prejudicial to safety.

According to M. Waseige, chief engineer of the Farman firm, some are of the opinion that everything should be accomplished electrically; others urge the generalization of hydraulic or pneumatic control. Having had occasion to look into these problems he came to the conclusion that for the present, and for a long time to come, the use of all three systems is essential. Thus, for instance, electricity is needed in connection with the wireless system; compressed air, by reason of its flexibility, is indispensable for de-icing and for automatic control; the hydraulic system also is hard to replace for certain controls. However, it is advisable to consider all of the applications in combination, with a view to simplifying and facilitating the designs, and to standardizing pressures, voltages, etc.

The simplest solution, and especially the one which is lightest in weight, is that of a centralization of the various devices for the generation of pneumatic, hydraulic or electric energy intended for the various controls, by grouping these mechanisms in an accessories drive box independent of the aircraft engine but driven from the latter.

This drive box, called accessories relay, consists of a case or housing containing all of the gears necessary for driving an electric generator, a high-pressure air compressor, a medium-pressure air compressor, a vacuum pump, and an hydraulic pump, the whole assembly being supported by the housing, which in turn is a part of the engine structure. Two universal joints, one at the engine, the other at the relay, are connected by a drive shaft, which then assures the same reliability as on an automobile.

This solution of the problem, which centralizes the controls and which insulates these members from the heat and vibration of the engine, naturally calls for the use of aluminum in the housing of the accessories relay, as well as in the production of the various mechanisms. It permits of keeping the weight of the relay down to between 80 and 90 lb. —*Revue de l'Aluminum*, January.

Production Engineers

Facilities for training in technical institutions for youths who wish to specialize in production engineering are decidedly limited. Probably this is due not so much to failure on the part of the principals of such institutions to realize the importance of the subject, as to the fact that the facilities available for practical instruction are almost non-existent in the great majority of cases. The difficulty is clearly brought out in the definition of a production engineer, given in a paper read by J. W. Berry at the annual meeting of the Association of Technical Institutions. The definition given of a production engineer is one who, by his training and practical knowledge, can

Aircraft Exports Skyrocket 276 Per Cent

Although dollar volume of February exports of "Automobiles, parts and accessories" was 8 per cent greater than that for the same month last year, volume for the second month of 1938 drifted downward approximately 18 per cent from the January figure to total $28,087,551. In virtually all other classifications a similar movement is apparent with 1938 February exports ahead of exports for the same month during the preceding year but lower in comparison with January, 1938.

Obvious exception—"Airplanes, seaplanes and other aircraft." Compared to a dollar volume of $745,220 in January, 1938, the second month's volume in this grouping skyrocketed 276 per cent. February 1938 volume also surged upward, moving roughly 130 per cent above February, 1937.

	FEBRUARY 1938		FEBRUARY 1937		TWO MONTHS ENDED FEBRUARY 1938		TWO MONTHS ENDED FEBRUARY 1937	
	No.	Value	No.	Value	No.	Value	No.	Value
EXPORTS								
Automobiles, parts and accessories		$ 28,087,551		$ 25,974,213		$ 62,483,222		$ 53,560,612
PASSENGER CARS								
Passenger cars and chassis	17,132	10,990,256	16,901	10,423,387	38,749	24,089,850	36,845	22,016,674
Low price range $850 inclusive	14,706	8,269,418	15,312	8,713,918	33,726	18,593,444	33,492	18,375,044
Medium price range over $850 to $1,200	2,088	2,159,828	1,340	1,263,516	4,344	4,351,821	2,785	2,628,338
$1,200 to $2,000	259	385,649	181	275,885	529	789,948	431	669,037
Over $2,000	79	175,361	68	170,068	150	354,637	137	344,255
COMMERCIAL VEHICLES								
Motor trucks, buses and chassis (total)	12,270	7,736,080	10,482	5,991,091	29,875	17,654,682	23,049	12,088,916
Under one ton	1,985	775,577	1,183	467,895	4,405	1,691,020	2,715	1,032,798
One and up to 1½ tons	7,892	4,252,307	7,386	3,540,290	20,997	10,961,625	17,158	7,790,283
Over 1½ tons to 2½ tons	1,639	1,254,422	1,363	1,118,967	3,104	2,439,643	2,277	1,835,985
Over 2½ tons	498	1,279,710	410	763,929	992	2,320,381	656	1,255,721
Bus chassis	256	174,064	140	100,010	327	242,013	243	174,129
PARTS, ETC.								
Parts except engines and tires								
Automobile unit assemblies		5,042,776		5,267,735		11,447,521		10,897,375
Automobile parts for replacement (n.e.s.)		2,794,913		2,597,553		5,905,955		5,107,178
Other automobile accessories (n.e.s.)		262,549		338,870		575,945		727,510
Automobile service appliances		372,430		470,478		915,118		992,998
Airplanes, seaplanes and other aircraft	68	2,803,013	35	1,218,940	98	3,548,233	82	2,642,411
Parts of airplanes, except engines and tires		1,707,528		2,436,198		3,556,442		4,648,598
INTERNAL COMBUSTION ENGINES Stationary and Portable								
Diesel and semi-Diesel	35	70,075	65	167,267	61	522,349	124	294,788
Other stationary and portable								
Not over 10 hp.	606	35,645	1,789	79,492	1,764	126,302	3,062	159,147
Over 10 hp.	332	92,473	210	130,264	658	188,289	332	208,245
Engines for:								
Motor trucks and buses	2,973	367,334	3,096	302,841	7,205	860,762	5,939	595,414
Passenger cars	5,634	460,960	9,800	645,278	12,970	1,064,432	18,875	1,255,135
Aircraft	103	611,881	108	747,611	202	1,195,660	151	937,881
Accessories and parts (carburetors)		229,305		195,742		480,271		381,712
IMPORTS								
Automobiles (dutiable)	47	31,630	145	83,897	153	86,960	247	154,470

interpret the design of a product, be it electrical, automotive or mechanical, and produce it by the most economical method, having regard to the quantity required, whether small or large. It would appear almost self-evident that, although the knowledge necessary to interpret the design of a product may to some extent be acquired in a technical institution, the skill to organize the productive facilities available in a factory in such a way as to reduce costs to a minimum can only be acquired as a result of considerable experience in an atmosphere where dividends are always of primary importance. This is not to say, however, that technical education in production engineering should be neglected, as there are many directions in which a youth may acquire information which will be of particular value should he ultimately specialize in this branch of works management. Mr. Berry laid down a suggested syllabus which covers a five-year course and includes workshop processes, mechanical technology, jig and tool design, and factory organization. On the completion of this course, a further three-year advanced production engineering course is visualized, in which such subjects as fundamentals of industrial administration, workshop organization and management, and engineering estimates and specifications, are included. — *Engineering*, March 11.

Automotive Rubbers Discussed

At a convention of the Rubber Division of the American Chemical Society in Detroit last week, Dr. H. A. Winkelmann, Dryden Rubber Co., Chicago, presented a paper entitled, "Developments in Automotive Rubbers."

In discussing the constant improvement being made in the properties of rubber goods, Dr. Winkelmann pointed out that today it is necessary to meet definite specifications as to oxygen bomb aging, compression set, heat and flexing resistance, oil resistance, sunlight aging, staining, odor, and adhesion to metals. In most cases the requirements must be met in products that vary in Shore hardness from 27 to 97.

Dr. Winkelmann stressed the need for improvement in reclaimed rubber in order to make possible its use in extruded stocks where shape and smoothness are most important.

TOOLS OF TOMORROW

Cone Gear Generators

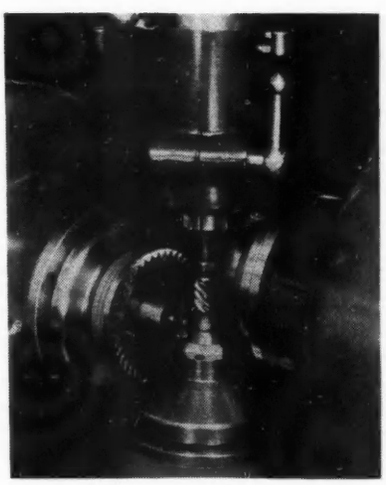
. . . Michigan Tool Co. automatic machines will handle gearing up to 4-in. center distance

Michigan Tool Co. has developed a line of automatic gear generators intended for mass production of "Cone" gears. As pointed out by the manufacturer, "Cone" gears—which cannot be cut on conventional gear cutting equipment since the large area surface contact machined into Cone worms and wheels prevents the use of conventional feed mechanisms—have heretofore been produced largely on semi-automatic machines of lower production rates.

In finishing Cone worm gearing, both worms and wheels are machined with the generating cutter and work at exact operating center distances. To achieve this the machining of either worms or wheels (with mating generating cutters) is actually in two steps. In the first or roughing operation, a narrow blade generating cutter (or hob) is fed into the blank until the required center distance is reached.

In the finishing operation there is a differential rotary feed—similar to taking up of backlash in gearing. With this rotary feed, the cutter blades shave material off the faces of the worm and wheel teeth until the teeth are finish size. This action is made possible by the design of the gearing. Teeth are not involute, but are generated by straight lines all tangent to the same base circle about the mating worm or wheel. Cone gearing, therefore, meshes with a pure sliding action, tooth design being such that oil is carried in and forced ahead of it by the entering tooth thus providing continuous film lubrication.

The new machines are designed to take care of gearing up to 4-in. center distance, with wheels up to 7-in. diameter and worms up to 3 in.



Close-up showing the cutting of a 1 to 4.875 step-up Cone gear. Note that the cutter blades are narrower than the space between the teeth, and that they are straight sided

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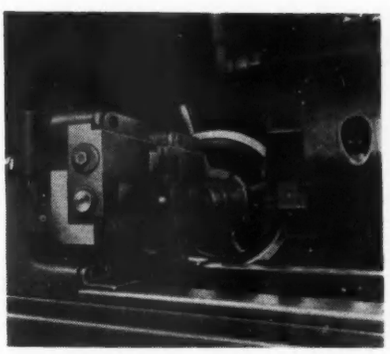

New carriage front or vise which is offered as optional equipment on the Landmaco threading machine by the Landis Machine Co., Waynesboro, Pa. The carriage is a combination floating unit which compensates automatically for any misalignment of the work with the die head, and a special vise jaw operating handwheel which delivers a hammer-like blow to effect the gripping or releasing of the work with minimum expenditure of effort

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Broaching King-Pin Holes

. . . Work done on new type pull-down Colonial Broach machine

Broaching king-pin holes in front axles is one of the jobs being done on a new type "Pull-Down" machine recently delivered by the Colonial Broach Co. The machine is of 5-tons capacity and has an 18-in. stroke. It is hydraulically operated and has variable speed control. Maximum broaching speed is 30 ft. per min. with a return speed of 60 ft. per min.

(*Turn to page* 488, *please*)

Business in Brief

Written by the Guaranty Trust Co., New York

General business activity showed an improvement last week for the third successive week. The index compiled by the *Journal of Commerce* stood at 70.8, as compared with 70.6 the week before and 103.3 a year ago. The current gain was largely the result of an upturn in steel operations, while a moderate improvement was made by lumber and electric production. Warm weather stimulated the movement of spring goods, and retail trade ranged from 3 to 8 per cent above that in the preceding week but was from 10 to 20 per cent below that in the corresponding period last year.

The Guaranty Trust Co.'s index of business activity for February stands at 69.1, as compared with 69.5 the month before and 94.5 a year ago. The company's index of wholesale commodity prices on March 15 was 64.7, as compared with 65.1 a month earlier and 89.7 a year earlier.

Railway freight loadings during the week ended March 19 amounted to 540,332 cars, which marks a decrease of 16,332 cars below those in the preceding week, a decline of 214,590 cars below those a year ago, and a drop of 28,519 cars below those two years ago.

Production of electricity by the electric light and power industry in the United States during the week ended March 19 was 8.7 per cent below that in the corresponding period last year.

Lumber production during the week ended March 12 stood at 51 per cent of the 1929 weekly average. The level of output was moderately higher than that in the preceding week, but both shipments and new business declined.

Average daily crude oil production for the week ended March 19 amounted to 3,433,550 barrels, as compared with 3,382,100 barrels for the preceding week and 3,448,150 barrels for a year ago.

Professor Fisher's index of wholesale commodity prices for the week ended March 26 stood at 81.9, as compared with 82.3 the week before and 82.8 two weeks before.

The consolidated statement of the Federal Reserve banks for the week ended March 23 showed an increase of $2,000,000 in holdings of discounted bills. Bills bought in the open market and Government securities remained unchanged. Money in circulation declined $3,000,000, and the monetary gold stock increased $3,000,000.

Vitrotex, an **inorganic textile insulation** manufactured from alkali-free glass for magnet wire, leads and coils, is described in a bulletin issued by the Anaconda Wire & Cable Co., New York.*

First comprehensive catalog by Cincinnati Milling Machine and Cincinnati Grinders, Inc., on its 6 in. and 10 in. plain hydraulic **grinding machines** has been issued as No. G-410.*

Catalog No. 38CG-2 is the latest publication issued by Saginaw Stamping and Tool Co., Saginaw, Mich., covering its line of **casters and trucks.***

Interesting promotional piece is **"How To Behave In Business"** recently sent out by WOR.*

Two bulletins, issued recently by F. J. Littell Machine Co., include one on the company's **power-driven straightening machines** and another on Littell **air blast valves.***

Considerable data on **automotive governors** has been assembled by Hoof Products Co. in a 64-page catalog. It is free to automotive executives and public officials.*

* Obtainable from editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia.

Production

(*Continued from Page* 463)

month five productive weeks against four in February.

The industry anticipates that April will show a gain over March, although not as great a gain as would be evident under normal seasonal influences. First weeks in April are not expected to show material gains over the average maintained in March with the rise coming during the latter part of the month.

General Motors production this week was off slightly from previous weeks largely because Oldsmobile was closed to permit a rearrangement of its working schedule so that employes could be assured of three days each week. GM, it is estimated, will account for slightly more than 19,000 of the week's total, Chrysler for 13,400 and Ford around 9000. Hudson's schedule was up a little to 1000 units, Willys maintained its pace at 800 and Studebaker ended the month with a slight reduction to 576 units. Graham-Paige resumed final assembly of cars this week and expected to run off between 150 and 200 cars.—J. A. L.

GM-Bendix

(*Continued from Page* 463)

Mr. Palmer has been with General Motors since 1919, joining the Chevrolet division in Flint as an accountant. Later, he became resident comptroller and in 1929, was named treasurer of Adam Opel, A. G., the German automobile factory controlled by General Motors. He became assistant general manager of Adam Opel, A. G., in 1933 and general manager of that company in July, 1936. Last July he was transferred to Detroit as assistant comptroller of General Motors Corp.

Mr. Doerfner joined Saginaw Malleable Iron in 1919, and except for the period from 1924 to 1928 when he was constructing a foundry for the Harrison Radiator Division of General Motors in Lockport, New York, he has continued with the same division. After extensive experience in the shops he was made general superintendent, and in 1928 became works manager.

R. K. MANGAN

. . . is now vice-president of The Buda Co., Harvey, Ill., in charge of advertising and domestic and export sales of Diesel and gasoline engines. Mr. Mangan has been associated with The Buda Co. in an engineering and sales capacity for approximately 20 years.

Bantam Produces 1580 Units During First Quarter

American Bantam Car Co., Butler, Pa., reports total output of Bantam cars for the first quarter of 1938 at 1580 units. According to Roy S. Evans, president, the company has stepped up production rate twice since the first of the year with a 25 per cent increase on Feb. 1 and another upward revision on March 1 of 20 per cent. Mr. Evans stated that the company expects to continue boosting production in order to produce approximately 10,000 cars this year.

Jeremiah Bingham

Jeremiah Bingham, president and treasurer of the Toledo Stamping & Mfg. Co., died in Miami, Fla., on Tuesday after three weeks' illness with malaria and pneumonia. Mr. Bingham was associated with E. W. Bliss Co. and A. O. Smith in Mil-

waukee before he went to Toledo, where he organized three stamping companies—Acklin Stamping Co., Bingham Stamping & Tool (now a division of Logan Gear), and Toledo Stamping & Mfg. Co.

Labor

(*Continued from Page* 463)

10 cent cut as a loan conditional upon profitable operations within the next year.

Negotiations over the renewal of the Chrysler-UAW agreement were adjourned for a day on March 29 and were to be resumed again on the last day on which the present agreement is presumably in effect. The corporation for a second time offered to extend the present agreement for another year, but was again rejected by the UAW representatives.

The union in turn offered extension of the current agreement providing a clause were added to the effect that no rights which it or any of its members might have under the National Labor Relations Act would be waived, but addition of this clause was rejected by the corporation's representatives.

The conferees reported that there had been no discussion of what would happen if the contract expired before negotiations to renew had been completed.

No word has been received from Washington on the petition of the Independent Association of Chrysler Employes asking the National Labor Relations Board to hold an election in Chrysler plants to determine which union shall represent employes in negotiations nor on a similar petition filed in "self-defense" by the UAW for an election. An independent union, the League of American Workers, has announced that it will ask the NLRB to place its name on the ballots if an employes' election is held.

Negotiations between representatives of Hudson and the Hudson local of the UAW were also still in progress in connection with the agreement which expires on April 8.

Chevrolet and Yellow Truck Get Army Contracts

The War Department has awarded contracts totaling $61,996 for motor vehicles to be supplied by the Chevrolet Division of General Motors, and the Yellow Truck & Coach Mfg. Co., Pontiac.

General Motors was awarded a $37,136 contract for 52 half-ton trucks, 28 to be supplied with reconnaissance and 23 with pick-up bodies.

The Yellow Truck & Coach Mfg. Co. will supply the Army with nine 1½-ton trucks under its $20,737 contract. The company also won a third contract to furnish four 1-ton trucks for $4,123.

URW Wins Firestone Vote

Employes of the Firestone Tire & Rubber Co., in a plebiscite held at the Akron factories March 29-30 and supervised by the National Labor Relations Board, voted the United Rubber Workers' Union of the CIO as their sole bargaining representative. The URW received 3696 votes and the newly formed Firestone Independent Employes Protective Association, 2554.

The URW has a contract with Firestone, signed a year ago, but never held a collective bargaining election there. It won collective bargaining rights last year at Goodyear and Goodrich in Akron.

Vote on Pierce-Arrow Fate Set for April 11

Pierce-Arrow Motor Corp. trustees went into Federal court this week and asked for a stockholders' and creditors' hearing to determine whether the company should be liquidated. Federal Judge John Knight set the hearing for April 11.

If stockholders and creditors vote to liquidate, the company's reorganization program to raise $11,700,000 in new capital will be abandoned and the Buffalo automobile firm probably will pass into history.

HAROLD E. CHURCHILL

. . . who has been appointed assistant research engineer for The Studebaker Corp., South Bend, Ind. Mr. Churchill has been engaged in research activities at Studebaker for the past 12 years.

A. VANDERZEE

. . . newly appointed vice-president of Chrysler Corp. in charge of the development of sales of the corporation's passenger cars and commercial vehicles. Mr. vanDerZee was formerly vice-president and general sales manager of the Dodge Division of Chrysler Corp.

W. M. Purves has been named general sales manager of Dodge to succeed Mr. vanDerZee. Mr. Purves held the post of assistant general sales manager of Dodge since 1926.

MEN OF THE INDUSTRY

H. B. HATCH, assistant general sales manager of Chevrolet since Nov. 1, 1933, has resigned to enter the retail automobile business on the Pacific Coast.

T. H. KEATING, assistant general sales manager for Chevrolet in charge of used cars in the eastern half of the United States, has been named to fill the corresponding new car post vacated by the resignation of H. B. Hatch. Three other promotions, necessitated by the same move, have been announced. **W. G. LEWELLEN,** who has had charge of used cars in the western half, is placed in charge of the eastern half. **J. E. JOHNSON,** southwestern regional manager, returns to Detroit to assume Mr. Lewellen's former duties. The post which he vacates at Dallas, Tex., will be filled by **ROY W. HILL,** who is promoted from assistant regional manager in the Great Lakes region.

G M Diesel Plant

By JOSEPH GESCHELIN

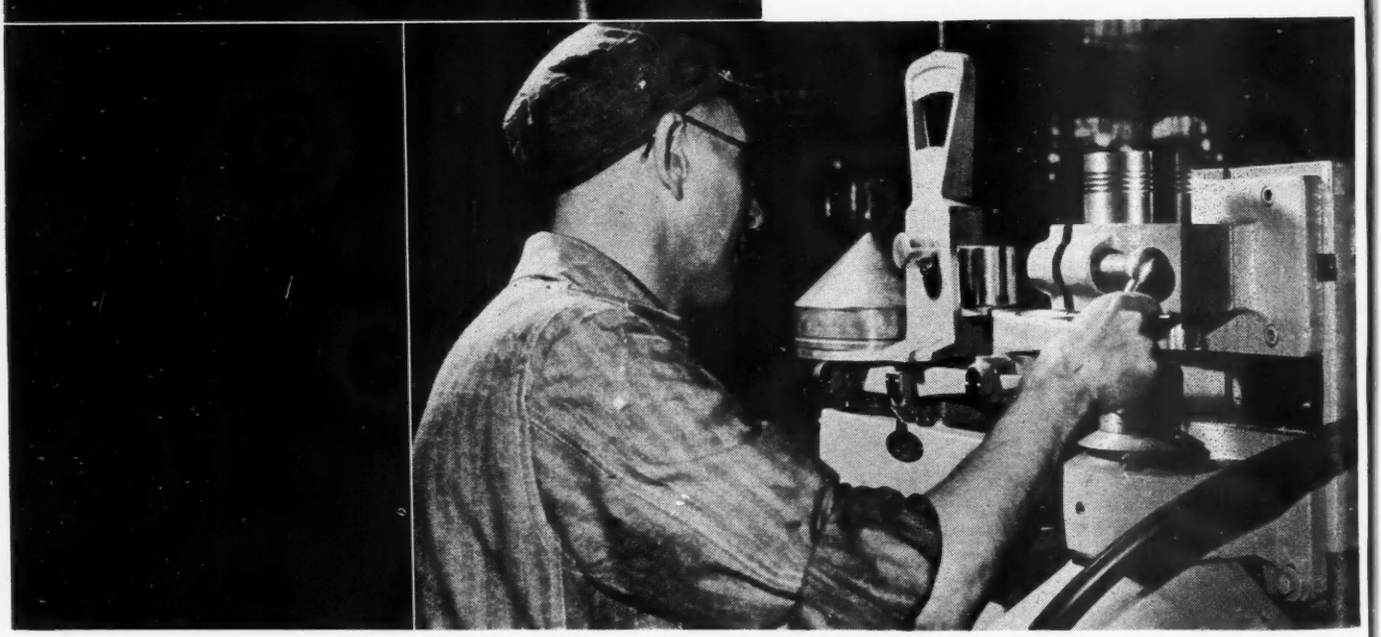
THE new plant of the Detroit Diesel Engine Division of General Motors Corp. was publicly opened on Jan. 19 (see AUTOMOTIVE INDUSTRIES issue of Jan. 22).

It was designed exclusively for the manufacture of a line of high speed automotive Diesel engines and marks a milestone in automotive production thinking in the complete coordination of engineering and production. In this respect the situation was quite ideal since neither product design nor plant layout had been crystallized but both were carried out simultaneously.

In essence this plant was laid out

(Left) Typical of the ingenious machine set-ups devised here for injector operations is this equipment consisting of two standard Delta drilling heads located above and below the table. Toggle mechanism plainly seen at the sides is used for hand feed, bringing both heads into action simultaneously

(Below) Machining pistons to exact weight and balance on special machine fitted with Milholland milling head



THIS IS THE TWENTY-FOURTH IN THE SERIES OF MONTHLY PRODUCTION FEATURES

. . . . *set up designed for economy and emphasizes craftsmanship applied to mass production*

to produce a line of four industrial Diesel engines readily adaptable for all manner of applications of Diesel power—for stationary equipment, for industrial and road building machinery, for tractors, trucks and buses—built around one basic cylinder. Thus there will be a one-cylinder engine, a three-cylinder engine, a four, and a six, all multiples of the basic cylinder.

The principle of interchangeability so well developed here has resulted in a set-up so simple as to take the mystery out of Diesel engine production and point the way to the utmost measure of economy in the future. If we were asked to intimate the key to the principles embodied

Looking down final engine assembly line showing method of assembly on special buggies

Cincinnati Hydro-Broach surface broaching machine finish-broaches bearing cap grooves

in the thinking and planning of the management, we would emphasize first—the idea of craftsmanship as applied to a mass-production product. Actually, those engines will be built according to the best practices embodied in current engine production and as time goes on the practices throughout will parallel the time-tried principles now established in building good heavy-duty gasoline engines.

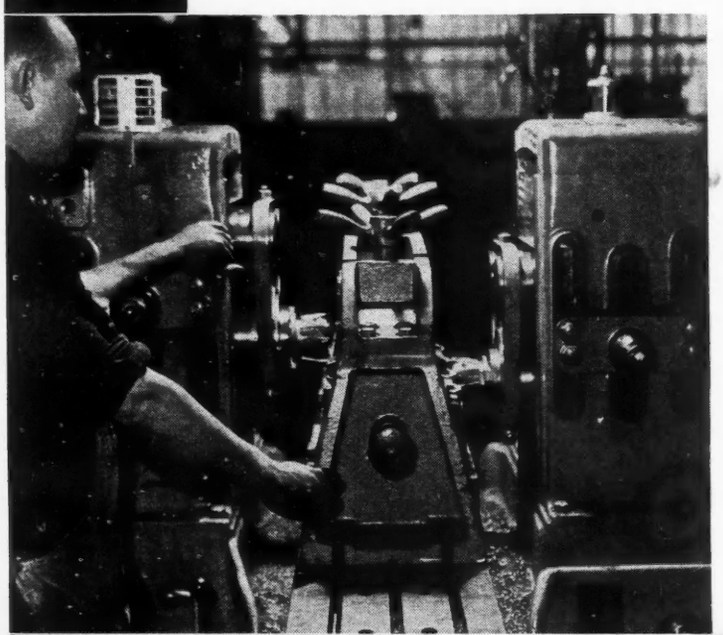
Naturally it is appreciated that the injector is a specialized piece of equipment embracing in its detail several elements that require precision work comparable only with fine instrument work. How these operations have been mechanized so as to place them on an economical production basis is a story all its own. In the main, however, the injector parts have been so designed as to permit the use of accepted production methods through the development of unique jigs and fixtures and interesting machinery.

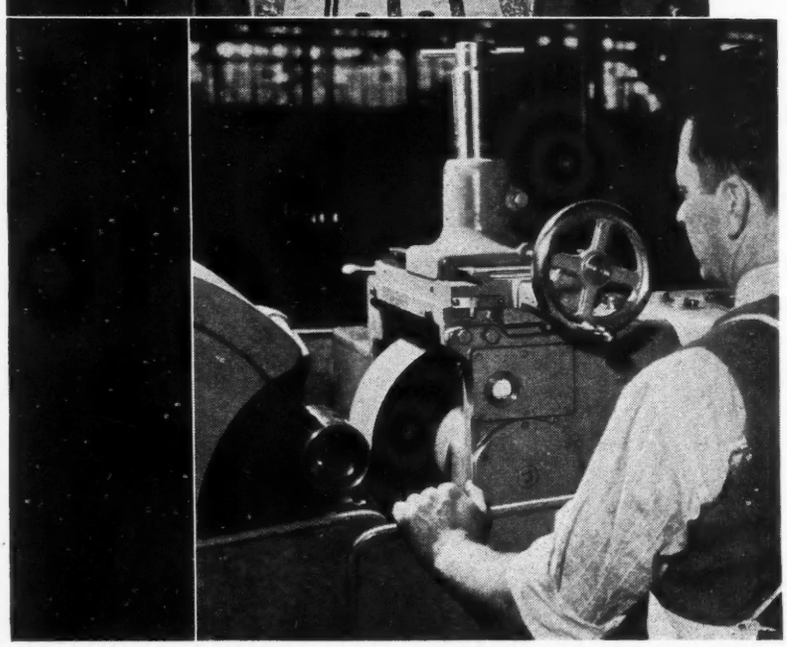
Factory Organization

General Manager	W. T. Crowe
Superintendent of Precision Department	N. Blake
General Plant Superintendent	L. Irwin
Plant Engineer	R. Curtis
Tool Engineer	I. Grant
Chief Inspector	C. L. Edwards
Metallurgist	A. H. Smith
Chief Engineer Small Diesel Engines	F. G. Shoemaker
Chief Engineer Large & Medium Diesel Engines	C. D. Salisbury
Chief Engineer Precision Dept.	C. W. Truxell, Jr.
Chief Engineer of Laboratory	A. F. Davis
Purchasing Agent	P. H. Kemp

(Top) Cylinder head sides are milled to size on this Kearney & Trecker duplex miller

(Bottom) Finish-grinding piston skirt on No. 4 Cincinnati centerless grinder





The factory proper consists of a monitor-type structure, 240 ft. in width and 480 ft. in length. It is of the latest factory building construction with the maximum of window glass area so as to provide the workers with the best possible light. Worker comfort is further enhanced by the use of high ceilings, spacious work places and aisles, and a paint treatment that serves to reflect and make the most of the daylight.

Flexibility of the machine layout has been assured by the use of Bull-Dog bus duct system throughout the plant. This makes it possible to shift machines at will without regard to power outlets since the duct can be plugged in anywhere along the line. With the straight line flow of materials through the machine shops to the final assembly line, materials handling has been greatly simplified. Despite the relatively moderate flow of work to the machine lines, the plant is traversed by an overhead trolley which carries hand hoists to facilitate the handling of heavy parts.

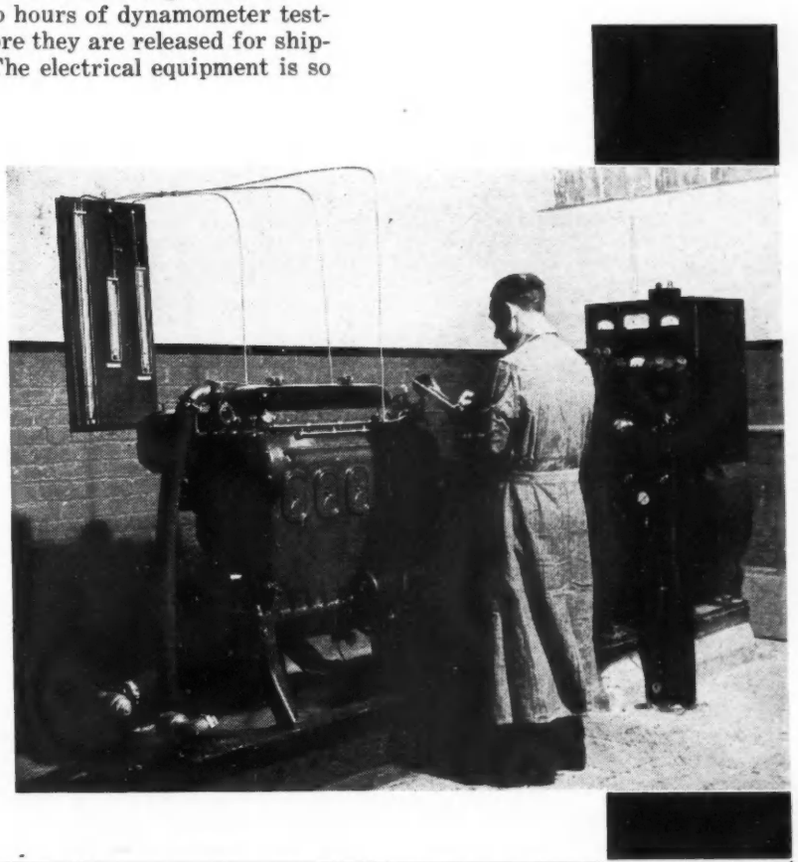
Gravity roll conveyors with conveniently located roll-over fixtures provide for the movement of parts from one machine to another. The final assembly line consists of a track with individual buggies equipped with a universal fixture which rolls the engines by means of a hand-operated worm-and-wheel mechanism.

Within the structure of the vari-

ous Diesel engine units of General Motors Corp., announced recently, it is of interest to note that the Detroit plant is the focal point for coordinated engineering and test facilities for all plants in the new set-up. The engineering department designs all Diesel engines developed for the corporation while the testing laboratory contains personnel and equipment for carrying on this work for the entire group.

A brief excursion through the plant reveals the fact that it is divided into various functional activities. Traversing the plant in its length, one will find that its largest area is devoted to the machine lines for producing the major parts of the engine. Next is the experimental machine shop in which are built experimental engines for future development. Finally at the far end of the building will be found the injector department which manufactures and tests all fuel injectors used on all G.M. Diesel engines wherever they are produced.

Adjacent to the machine stop is the engine assembly line, running at right angles to machine lines. And adjoining this is the final test department where all engines are subjected to hours of dynamometer testing before they are released for shipment. The electrical equipment is so arranged as to absorb the power of the engines on test, and to transmit it in the form of electrical energy to



Close-up of one of the ten routine production test stands for completed engines

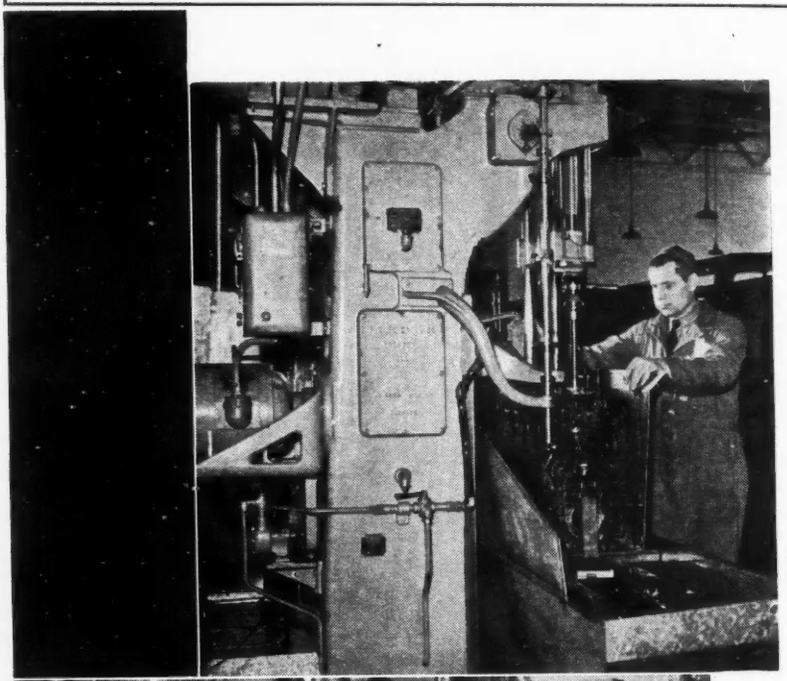
Factory Routing Cylinder Block

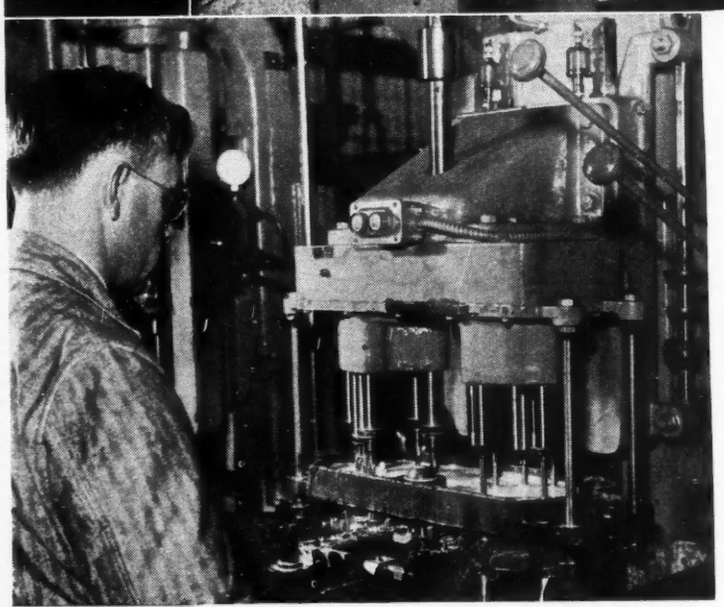
OPERATION	EQUIPMENT
Inspect casting	
Spray sealer	
Rough mill top, bottom and bearing cap groove	Fitchburg duplex miller
Semi-finish mill top, and finish mill bottom	Fitchburg duplex miller
Drill and ream locating holes	Baush special drill
Mill rough ends	Fitchburg duplex miller
Rough mill sides	Fitchburg duplex miller
Rough bore cylinders	Foote-Burt boring machine
Rough bore cam, crank, balance shaft, gear center and plug holes	Barnes boring machine
Drill oil gallery hole	Foote-Burt drill
Straddle mill crank bearings and mill bearing lock grooves	Sundstrand mill
Finish broach bearing cap groove	Cincinnati broach
Drill all holes in top and ends	Baush 3-way drill
Tap holes in both ends	Baush 2-way drill
Drill (4) oil holes in top	Leland-Gifford and special machine base
Drill oil level gage hole	Leland-Gifford and special machine base
Drill oil holes in lower side	Barnes drill
Machine plug holes in sides. Drill and tap balance of holes in top, sides and bottom	Carlton radial drill
Drill holes in bottom and sides	Baush 3-way drill
Counterbore bearing cap stud holes and oil holes	Barnes drill

OPERATION	EQUIPMENT
Tap all holes in top and sides	Baush 3-way drill
Tap oil level gage hole	Leland-Gifford and special machine base
Drill oil holes in bottom	Barnes drill
Tap oil holes in bottom	Carlton radial drill
Tap holes in bottom	Baush 3-way drill
Assemble stud and bearing caps	Bench or conveyor
Semi-finish and finish cam, crank and balance shaft holes	Barnes boring machine
Chamfer front and rear cam and balance shaft holes	
Semi-finish bore gear center holes, finish ream plug holes and two dowel holes	Barnes boring machine
Finish bore gear center holes	Barnes boring machine
Eccentric mill sides of front and rear bearings	Cincinnati mill
Semi-finish bore cylinders	Baush boring machine
Finish mill top	Fitchburg duplex miller
Finish mill ends	Fitchburg duplex miller
Finish mill sides	Fitchburg duplex miller
Finish bore cylinders	Baush boring machine
Counterbore top of cylinder bores	Defiance drill
Assemble plugs and water test	Bench or conveyor
Wash and blow off	
Assemble sleeves	General flexible power press (20-ton)
Hone sleeve in assembly	Barnes honing machine
Rewash	
Inspection	

Factory Routing Connecting Rod

OPERATION	EQUIPMENT
Inspect—dip in silicate of soda	Bench
Grind sides crank end	Gardner 20 in. double spindle grinder
Center ends to gage	Sundstrand centering machine
Grind sides (pin end)	Gardner 20 in. double spindle grinder
Turn outside diameter large end	LeBlond 11 in. lathe
Drill and ream wrist hole and eccentric bore crank hole	Barnes Hyd-ram drill—single spindle
Mill bolt bosses and split cap from rod	No. 28 Producto-matic mill
Drill oil hole	Leland-Gifford step driller (2)
Drill and ream bolt and drill and ream oil holes and burr	Natco hydraulic drill press Bench and Hicycle motor
Grind the joint face on rod and cap	Gardner disk grinder
Cut bearing slots and mill oil groove in rod	Kearney & Trecker mill
Wash—Dry with air	Air hoist and wash tank
Assemble cap to rod	Bench and Hicycle motor
Grind crank faces	Heald grinder
Size bore crank and wrist pin holes	Barnes No. 210 drill press
Cut oil groove. Counterbore wrist pin. Chamfer crank hole	Barnes No. 210 drill press
Drill and ream oil spray nozzle hole	Leland & Gifford drill press
Diamond bore wrist and crank holes	2-spindle Ex-Cell-O precision boring machine
Balance both ends of rod	
Hone both ends of rod	Barnes honing machine
Wash in clear hot water	Air hoist and tank
Inspect	Bench





(Left) New Barnes honing machine fitted with Micromatic hones is used for honing the dry cylinder liners after assembly in the block

(Bottom) Drilling and reaming connection rods on heavy-duty Natco drill press with special multiple spindle head

the main powerplant, thus converting waste power into useful and usable energy.

Coming to the machine shop we find that it has been possible to approach mass production practice even with job-lots, through the principle of interchangeability based on the use of multiples of a single standard cylinder. This finds its best expression in the machine lines for the major units of the engine. Consider that such equipment is most expensive as to first cost and requires, in addition, expensive jigs and fixtures for the character of precision demanded here. Here is one of the best examples of the coordination of engineering design and production planning to be found anywhere. Cylinder blocks and cylinder heads are so designed as to be geometrically similar for all sizes and end-for-end. This means that no matter how you turn the casting, both ends have the same shape and take the same number and spacing of holes. Moreover, the ends of all blocks whether they have one, three, four, or six cylinder barrels, are precisely alike; and the drilling of the top and bottom is the same, save for the fact that a larger block will have more holes.

This basic conception of design makes it possible to use but one line of special machines for the entire range of engines no matter what number of cylinders. It even goes

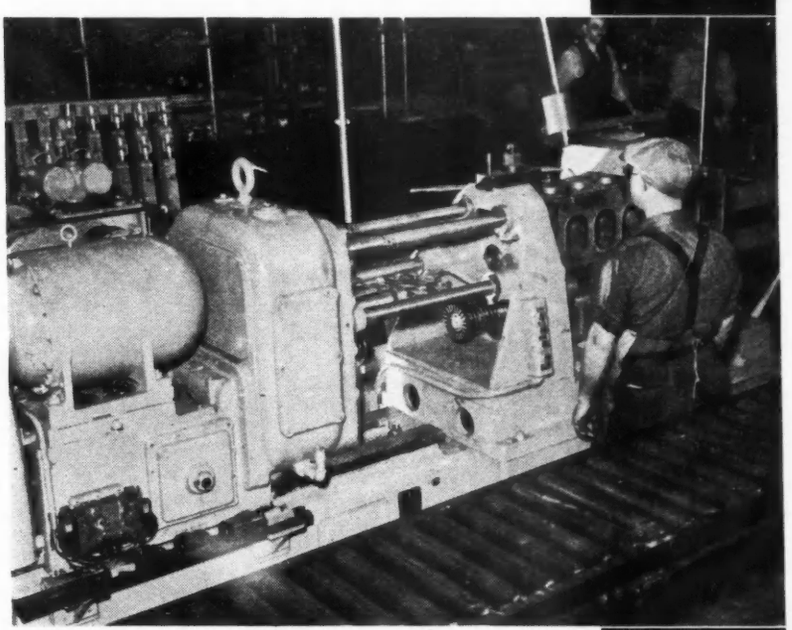
further since the similarity of the blocks makes it possible to use many fixtures interchangeably and to utilize multiple-spindle drilling and tapping heads without change.

How completely this philosophy has penetrated production planning may be gaged by the set-up for boring the dry cylinder liners. For boring, the liners are assembled, three at a time, into a fixture which has the same form and size as a three-cylinder, cylinder block. Then the fixture with its charge of liners goes into the same machine and same fixtures as are used for boring the cylinder barrels. The only change required is to replace the boring cutters with cutters of smaller diameter, a matter of only minutes for the changeover.

The blower department is a gem of mechanical ingenuity, and probably the first of its kind in this country. Its chief attribute is the simplicity of equipment and process for an operation so intricate and precise. Several examples will suffice to give the picture. For example, the blower housing has two bores that must be finished to accurate limits. This is done by boring the housing on a single-end Heald precision boring machine with its massive boring spindle. As one bore is finished, the table indexes the work forward, hydraulically, to complete its mate. However, this is but a roughing operation. Subsequently, each housing is processed in the same machine for a second and final boring operation.

Machining of the blower rotor is a very unique operation. The rotor is a three-lobed affair, each lobe having a spiral form along its axis. There is specially designed machine set-up to handle this operation automatically. It takes three separate settings of the rotor to complete the job, using a special formed cutter that encompasses a third of the profile each time. As the cutter traverses the face of the rotor, the rotor casting is automatically turned by an indexing mechanism so as to produce the spiral form.

A striking note of modernity is found in the installation of a new type of equipment for heating fly-



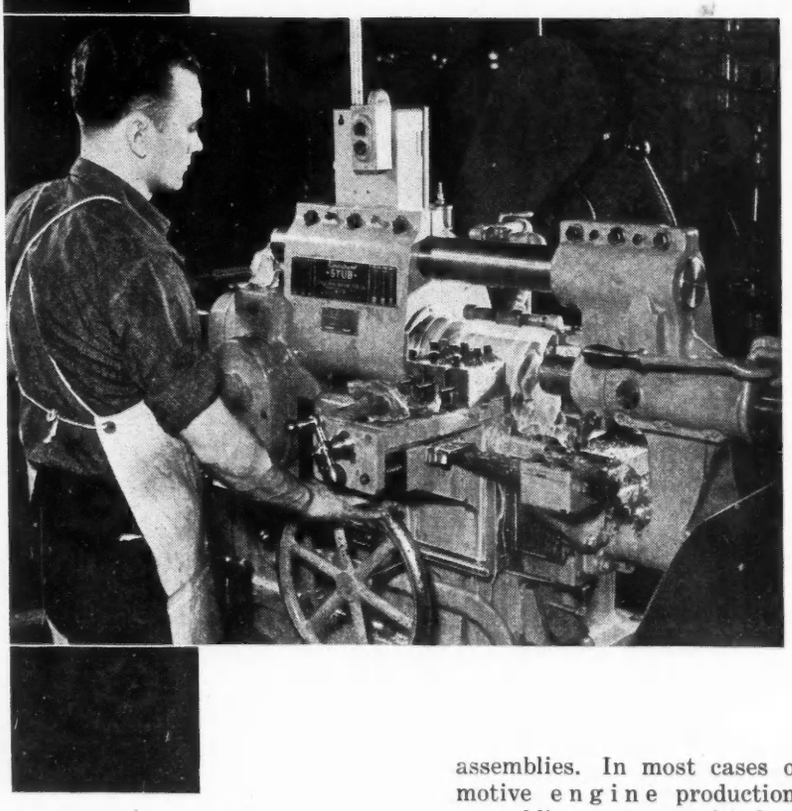
This massive W. F. & John Barnes boring machine is used on cylinder block for rough-boring cam and crank bores, gear center, plug holes

Factory Routing Injector Body

OPERATION	EQUIPMENT
Heat, quench, temper and sandblast	Rotary hardening furnace
	No. 53 Pangborn sandblaster
Test Rockwell hardness	Inspection
Turn nut end. Rough and finish form, center drill, etc.	No. 3 Warner & Swasey turret lathe
Turn spring end. Rough form. Center drill, drill and turn outside diameter, cut to length and face off	No. 3 Warner & Swasey turret lathe
Mill boss and clamp notches	U. S. hand mill special 3 spindle head
Stamp part number and assemble number	No. 4 Noble & Westbrook numbering machine
Hand file high spots on numbers	Bench
Drill (4) 0.089 in. diameter fuel holes and drill and ream 0.0250 in. diameter rack hole	Leland-Gifford drill (6-spindle)
Drill No. 39 diameter overflow hole, drill and ream 0.1875 dowel hole, drill and tap 5/64 in. tap drill	Delta drill (4-spindle)
Drill and square (2) 13/32 in. filter holes	No. 2 Avey step drill (2-spindle)
Tap drill (2) 37/64 in. filter holes. Ream (2) 0.5625 in. filter hole. Ream (2) 41/64 in. flat bottom counterbore	Delta drill (3-spindle)
Tap (2) 5/8 in.—24 filter holes	No. 2 Avey tapper
Ream (2) 0.584 in. filter holes. Chamfer 0.703 in. diameter nut end	Delta drill (2-spindle)
Drill 1/8 in. hole	Delta drill (single spindle)
Ream 0.937 in. hole	Delta drill (single spindle)
Diamond bore (2) 0.531 in. diameter and face bushing joint face	Heald Borematic
Cut 0.096 in. groove	Hand mill
Tap No. 3—48 hole	Haskins tapper
Ream 4 0.0937 in. fuel holes (1) hole at 11 deg. 27 min. (1) hole at 36 deg. 0 min. (2) holes at nut end	Delta drill (3-spindle)
Burr	Bench
Inspection	

Factory Routing Cylinder Head

OPERATION	EQUIPMENT
Grind top of rail	Osterholm grinder
Rough mill bottom. Leave 0.020 in. for finish. Mill pads for water manifold and governor control shaft	Kearney & Trecker duplex miller
Mill sides	Kearney & Trecker duplex miller
Drill holes in bottom	Defiance drill
Profile mill top	Newton mill
Mill ends	Kearney & Trecker simplex miller
Drill oil gallery hole	Foote-Burt drill
Drill all holes in both sides	Defiance drill
Drill all holes in top	Defiance drill
Semi-finish and finish injector hole	Barnes drill
Finish ream valve guide holes	Barnes drill press
Drill injector dowel hole	Special machine with Atlas drill head
Core drill cam follower holes	Defiance drill
Tap holes in all sides, drill ¼ in. oil hole in bottom. Drill two ½ in. water holes in 3 and 4 cylinder heads. Chamfer injector holes. Chamfer both ends of cam follower hole. Spotface fins on top left by profiling cutter	4 ft. Cincinnati Bickford radial drill
Drill and tap holes in ends. Rough and finish plug holes	4 ft. Cincinnati Bickford radial drill
Semi-finish bore cam follower holes	Heald precision boring machine
Machine groove in cam follower holes	Barnes drill
Finish bore cam follower holes	Heald precision boring machine
Bearingize cam follower holes	Edlund drill
Finish mill bottom	Kearney & Trecker duplex miller
Machine valve seat hole	Barnes drill press
Assemble injector tube and spin bottom	Special machine — high speed hammer
Assemble plugs and water test	Bench
Ream injector tube	Barnes drill
Assemble valve stem bushings	Hannifin air press
Ream valve stem bushings	Edlund drill
Grind valve seats	Kwik-Way valve seat grinder
Inspection	



Rough turning outside diameter and turning ring grooves in standard piston on 8 in. Sundstrand stub lathe

wheel ring gears. This machine heats the rings by electric induction, discarding the previous practice of heating by flame or in a furnace.

One of the most important of the precision operations is that of producing piston and connecting rod assemblies. In most cases of automotive engine production, these assemblies are permitted to vary between fixed limits and then are assembled into balanced sets by selective matching of pistons and rods. At the Detroit Diesel plant this procedure is not tolerated. Each of the parts is interchangeable as to size and weight with its fellows and each assembly conforms to the same weight specification. This is achieved by the use of ingenious machines which automatically weigh the piston or the rod and machine it precisely to the weight required.

Outer diameters of pistons and cylinder liners are finished to close limits both as to size and surface quality by operations on centerless grinders—huge machines of the very latest type.

Connecting rods not only are precision-bored to achieve the desired control of size and roundness, but are subsequently honed to produce the desired surface finish.

Although four different crankshafts are used in the production of the line of industrial engines, each shaft has features of interchangeability with respect to bearing sizes, and details of the end flanges. However, to expedite the production of this line of shafts and particularly because of the special Tocco-hardened pins, the G.M. Diesel shafts are produced to exacting specifications and tolerances by The Ohio Crankshaft Co. All crank pins and bearing surfaces are hardened by the well-known Tocco induction surface hardening process to meet the requirements of durability in heavy-duty operation. While the Detroit plant buys the shafts completely finished, each shaft is inspected 100 per cent and checked for static and dy-

namic balance on a vertical GMR balancing machine.

To supplement the foregoing highspots, we have reproduced elsewhere in this article the official factory routings, giving the sequence of operations for several of the major parts of the engine.

The injector department is rather remarkable for the fact that a research-developed mechanism has been broken down into its elements and mechanized for the utmost economy and interchangeability. For this purpose, it was found necessary to develop special equipment performing unique operations. Yet analysis of the equipment reveals the fact that much of it is an adaptation of familiar machinery, some of which is of the simplest type imaginable.

While it is quite beyond space limitations to go into the details of all of the interesting operations in this department, we have singled out a few of the outstanding operations and have supplemented these comments by reproducing several of the factory routings in this department.

Apart from the precision operations on the injector bore and piston where the clearance is held within fifty-millionths of an inch as measured on the P & W Electrolimit Gage, the biggest problem is that of precise positioning and accurate location of many extremely fine holes ranging from 0.002 to 0.008 of an inch in diameter which have to be drilled clear through relatively long pieces. This has been worked out most ingeniously by the development of special double-end drilling heads made up from inexpensive drilling units such as the Delta line.

Most of these special units consist of two heads set vertically—one above and one below the drilling table, both connected by a toggle mechanism. In operation it is possible to achieve many interesting combinations. For example, it is possible to drill a long hole by drilling part way through from the top and then completing the hole from the bottom. Or it is possible to drill from the top and then come through with a reamer or tax from the bottom. Still another combination drills

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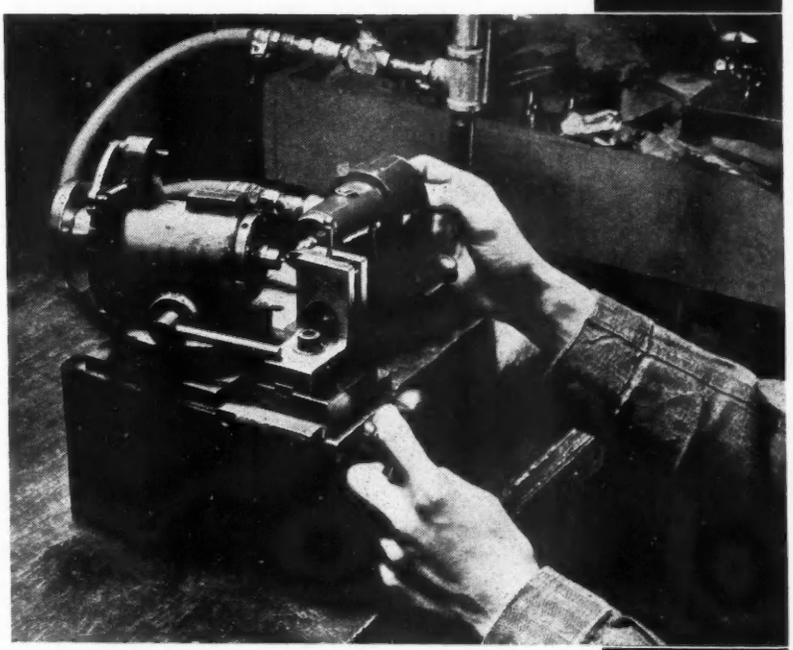
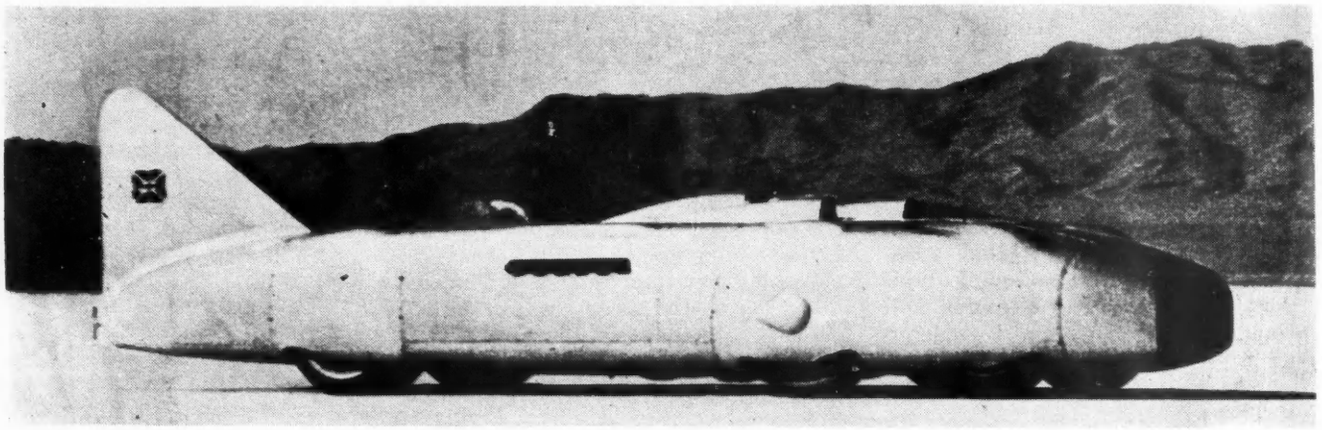


Simple equipment developed here solves most difficult problem of drilling the series of fine holes in the injector spray tip. A universal indexing head, holding the spray tip is seen at the left. The drilling head, right, is a tiny air turbine operating at high speed. The drill is fed in by hand as may be seen in the photograph

Factory Routing Bushing

OPERATION	EQUIPMENT
Cut stock to furnace length (approx. 48 in.)	Power saw
Normalize and sandblast	Heat treat
Inspection	Rockwell
Turn outside diameter. Drill and ream 0.240 in. hole, drill 11/32 in. hole, chamfer, cut off	Turret Lathe No. 3 Warner & Swasey
Face to length, chamfer hole and outside diameter	Turret Lathe No. 2 Warner & Swasey
Drill all holes	Special Delta 3-way machine
Countersink 30 deg. holes. Ream 0.0625 in.—2 holes, form radius—2 holes	4-spindle Delta machine
Ream 0.240 in. hole to remove burrs from cross holes	U. S. Electric head
Harden and draw	Heat treat
Rockwell	Inspection
Grind outside diameter plus 0.000, minus 0.002 in.	Cincinnati centerless grinder
Ream 0.240 in. hole to remove scale from cross holes	U. S. Electric head

OPERATION	EQUIPMENT
Grind inside diameter (rough) for nitriding	Greenfield grinder
Surface grind 0.406 in. dimension to 0.4075 in. Also over-all	Surface grinder
External grind. 0.5306 in. dia. to 0.5325 in. plus, 0.001 in. minus 0.000 and bump shoulder	Brown & Sharpe No. 11 external grinder
Break all sharp edges	Schauer Electric head
Nitride	Heat treat
Rockwell (superficial)	Inspection
Finish grind inside diameter	Greenfield grinder
Finish grind outside diameter 0.5306, and bump shoulder. Also face opposite end	Brown & Sharpe No. 11 grinder
Surface grind small end (finish)	Surface grinder
Grind high pressure relief groove	Rivet grinder
Lap seal end	Norton lapper
Lap hole	Electric head (bench) Sunnen head
Inspection	



Eyston's Thunderbolt

Set World's Record

IN the development of Captain Eyston's Thunderbolt, with which new world's speed records were established on the salt beds of Utah last summer, M. J. Andreau, a French consulting engineer and aerodynamic expert, was called in to help improve the streamlining. A design for the car, including its shell or body, had already been worked out in England, but evidently it was Captain Eyston's desire to make absolutely sure, before venturing on the record trial, that the car had the ability to better the then existing record and that it was safe at the enormous speed which it would have to attain. The various steps in the development of the final design were outlined by M. Andreau in a talk at a recent session of the French Society of Automobile Engineers.*

The first problem that was attacked was to make a thorough analysis of Sir Malcolm Campbell's Blue Bird from the points of view of power available and power required to overcome rolling and air resistances. A very accurate test furnished the following data: Engine output, 2230 hp.; transmission efficiency, 90 per cent (two pairs of gears). This leaves 2000 hp. available at the wheel rims. Tires were inflated to 120 lb. per sq. in. The speed attained was 275 m.p.h.; the forwardly projected area, 26.9 sq. ft., and the weight, 10,868 lb.

In applying a formula for rolling resistance developed by him, M. Andreau found that it would be 59.4 lb. per 1000, and therefore would amount to about 660 lb., to which must be added about 110 lb. for the rotation of the wheels, which cannot be neglected at these high speeds. We then have 770 lb. for the total rolling resistance. The propelling force being 2750 lb., there remains 1980 lb. to overcome the air resistance, and this corresponds to an air resistance coefficient of practically 0.001 (actually 0.00102). This figure, moreover, was confirmed by a calculation of the air resistance based on the form of the vehicle.

M. J. Andreau Consulted

After this information had been obtained, Captain Eyston arrived in France with a preliminary design, which he submitted to M. Andreau. This racer was to have a single engine of 2500 hp., and was to weigh four tons (8800 lb.). To have sufficient margin to beat the existing record, and in view of the inflation pressure specified by the tire makers, which was less than that used by Campbell, it would have been necessary to reduce the air-resistance coefficient to 0.00085, but calculation indicated that it would be 0.001 at the least. This would have made the attempt hopeless, especially when it was considered that the power would be materially reduced by the high altitude of the Utah salt beds, on which the test was to be made.

Some months passed, during which nothing was heard from Captain Eyston, who, however, was busy during this period. Then, one nice day in March, 1937, he bobbed up again —with another design. The chassis and the mechanical parts were being built, and a scale-model of the vehicle had been built and tested. It was a slight improvement over the first model, because the Captain had taken advantage of some suggestions made by M. Andreau and had improved the profile somewhat. As regards the chassis of this design, it was to all intents and purposes the same as that used in the later successful attack on the record. It had two Rolls-Royce engines of the Schneider-Cup type, four steering wheels arranged in two conjugated pairs, and two rear twin driving wheels. In short, it was a very large machine and quite radical in some respects. The new layout of the body gave an air-resistance coefficient of 0.00085. As the record attempt was to be made in Utah, in estimating the engine power it was necessary to take account of the high altitude and the warm climate of that State. The altitude and temperature corrections gave

$$0.88 \frac{288}{293} = 0.865,$$

*Captain Eyston, by the way, was put in touch with M. Andreau by W. F. Bradley, Paris correspondent of Automotive Industries.

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and the mechanical efficiency of the transmission had been found to be 93 per cent. It was thus permissible to figure on 80 per cent of the normal or rated engine power on the rims of the driving wheels, and this gave 3400 hp. The weight of the vehicle was estimated at a little less than seven (metric) tons, or 15,400 lb. Captain Eyston greatly impressed M. Andreau by being able to give the weight of every part of the car offhand. The weight of the car in its final state, after modifications had been made in the cooling system, was 15,400 lb.

The Dunlop Company insisted on an inflation pressure not exceeding 90 lb., because the 120 lb. pressure carried in the tires of the Blue Bird had given trouble. With this inflation pressure, at 292 m.p.h. the air resistance would absorb 1200 hp. and the rolling resistance 1530 hp., together 2730 hp. The maximum speed would have been 304.5 m.p.h., which was considered an insufficient margin above the record of 301 m.p.h. Therefore, to make sure of success, it was necessary to change the plan materially. M. Andreau advised Captain Eyston to cut down the weight of the car as much as possible, to increase the inflation pressure, and to improve the streamlining.

As regards weight reduction, after the whole chassis had been gone over once more, it didn't seem possible to cut the weight materially without incurring undue risks. Not even 200 lb. could be taken off, as the whole structure had been designed in the first place with an eye to keeping the weight down to a minimum. Little, therefore, could be done in that direction, except as regards the cooling system, which will be dealt with a little further on.

The Dunlop Company at last consented to an increase in the inflation pressure to 100 lb., but they would go no further. This also involved risks, and Eyston, in spite of his "nerve" (of which he has given abundant proof), did not want to go beyond this pressure either.

The only other possibility lay in improving the streamlining, and M. Andreau says he had the impression that much could be accomplished along this line. Two disturbing factors were that construction was already under way and that the restraints imposed by the chassis had to be borne up with, as it was already in existence. After a number of plans had been evolved, partly by calculation and partly by graphical methods, he arrived at the form which was finally adopted. The wheels were enclosed in the body, with only comparatively small clearance for steering motions. At the front the profile was elliptical in form, at the rear it was parabolic. The lay-out included continuous variations in curvature, and junctions of the second order.

In the original English project this vehicle, which measured 33 ft. in length, came within 3 in. of the ground and had a flat bottom, which feature was based on wind-tunnel tests in which a stationary "floor" was used. These tests seemed to indicate that the air resistance would be less if the vehicle was very close to the ground. While this observation is correct, it does not apply to the case where there is relative motion between vehicle and "ground." Andreau found it possible to increase the minimum ground clearance to 7 in.

Calculation of the air resistance for the complete vehicle gave a very low coefficient, but it was necessary to take account of the exhaust outlets, the air intakes, and the ventilating openings. Therefore, an air-resistance coefficient of 0.00085 was figured with. The frontal area of the car was 25.6 sq. ft. The very low air-resistance coefficient of 0.00085 is due to the high Reynolds number applying to the Thunderbolt. The Reynolds number for a given gaseous medium is proportional to the product of the velocity and a linear dimension, and this is about seven times as large in the case of the Thunderbolt as in that of a conventional car. When one compares the actual machine with a wind-tunnel model, built to a scale of 1:10, one becomes scared at the large extrapolation ratio, which is 46. "It takes a very good aim to hit the mark at that distance." For this reason M. Andreau confined himself entirely to calculations and did not build and test a single scale model. The result, nevertheless, was en-

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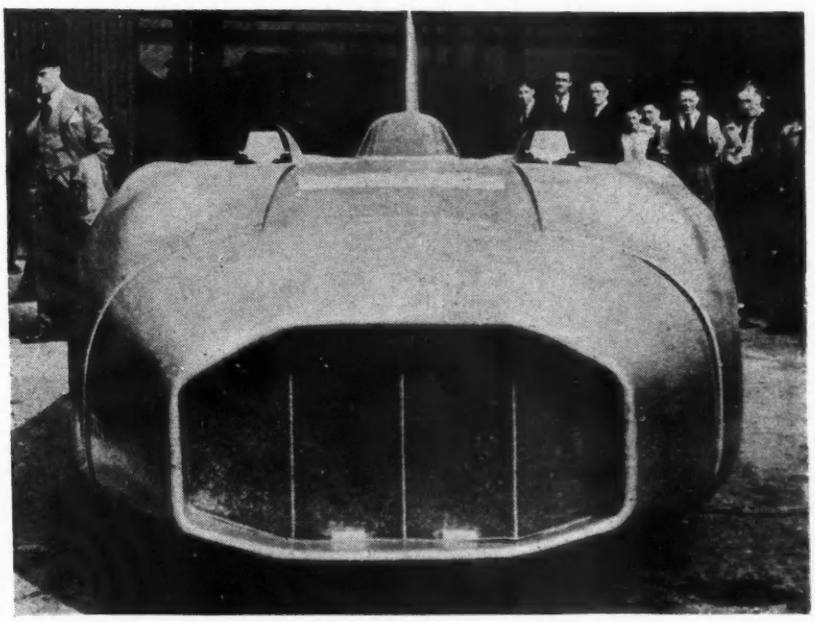
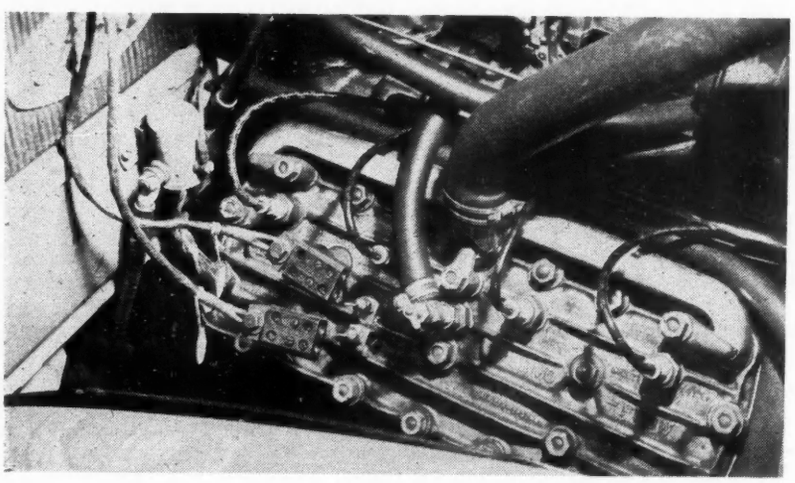


Thermo-Flow Cylinder Head Permits 20 per cent Higher Compression

Interior of Federal - Mogul test car, standard 1938 Ford V-8 sedan, showing thermocouple switch on dash and indicating temperature meter on the seat.

As the direct result of several years of actual operating experience with the original water-cooled copper cylinder head, the Federal-Mogul Corp., Detroit, Mich., recently completed a new research program resulting in the development of an entirely new replacement cylinder head. The new Thermo-Flow power head, a comparatively simple casting of a special copper alloy, not only produces far greater economy than the former design, but is being offered at a greatly reduced price. The retail price is $39.50 per set complete, f.o.b. Detroit, for a Ford V-8, either 1937 or 1938 model.

Chief virtue of the Thermo-Flow head is the ability to produce combustion chamber temperatures approaching what is considered good engine condition for various throttle openings (about 500 deg. Fahr. at wide-open throttle). With the new heads, compression ratio is increased so that the combination of proper temperatures and high compression yield a tangible increase in horsepower as well as an improvement in fuel economy. Yet this is accomplished without changing the standard factory carburetor or ignition setting. Moreover, it is possible to operate on regular fuels with the minimum "pinging," even under most adverse conditions, due to the excellent heat-dissipating qualities of the material and "spot and fin" cooling combined with a modified combustion chamber form and more favorable spark plug location.



Thermo-Flow power head installed in test car showing location of two of the thermocouples for measuring head temperature

It is claimed that with the new Thermo-Flow head, instantaneous cold-weather starting is obtained with minimum choking. In operation it is claimed to produce exceptional agility and acceleration in traffic and on grades. Thermo-Flow permits up to 20 per cent higher compression ratio; is said to produce up to 15 per cent more power; and to improve fuel mileage up to 20 per cent. It is said that for trucks and buses this will effect up to 30 per cent greater economy per ton mile.

According to the manufacturer, the new head will not corrode and its high expansion coefficient eliminates all danger of cracking due to overheating, freezing or sudden chilling.

Just Among Ourselves

Even the Naive Are Cautious

IN a letter to the *New York Times*, Felix H. Levy, formerly a special assistant to the attorney general of the United States, throws light on some recent White House querulousness respecting the automobile industry.

Mr. Roosevelt has complained that when he asked automobile executives to present further recommendations designed to stabilize employment in the industry by smoothing the peaks and valleys of production, their answer was "legalistic" in tone and would require some time to digest. The implication was that the answer was evasive and not in the spirit of Mr. Roosevelt's request for cooperation.

There is more to this than meets the eye, Mr. Levy demonstrated. An invitation for manufacturers to agree on ways and means of levelling out production is an invitation for them to violate the Sherman Law, which does not distinguish between such agreements when they are in the public interest and when they are not.

And even when the invitation to risk a law violation comes from so distinguished a devil's advocate as the President of the United States, only the more naive among our industrialists will probably rush to comply.

Of the legal barriers to production control throughout the industry Mr. Levy says: "The indisputable fact is that the Sherman Law is perfectly clear in its denunciation of every agreement among competitors, even when induced by good motives or followed by good results."

Among the English-speaking nations the law is unique because it does not draw a distinction between agreements which are or are not in the public interest.

Under such conditions it does not seem strange that the automobile industry, whose every major move is front-page news, should be a little wary of putting its neck in a noose.

Worth Doing Once More

LAST week in New York, Studebaker went to considerable trouble to honor its foreign distributors who did the best job (as decided by a jury) of presenting the 1938 line of Studebaker to their constituents. Differences in the nationality and environment of the contestants naturally produced a considerable variety of stunts for the consideration of the judges.

No less colorful, if less exotic, would be such a contest among the domestic dealers and distributors of Studebaker—or any other company in the industry. Prizes could be awarded in several categories, according to the size of dealership, and perhaps there could be regional prizes in order to add local interest and competitive spirit to the contest.

Dealers, like everyone else, like appreciation. A well run contest of the sort pioneered by Studebaker should go a long way to build dealer good will for other organizations.

Another Child for GM?

IT is perhaps opportune to mention at this point that some of the principles of General Motors management are apparently being extended to the Bendix Aviation Corp., giant "mother" of the Bendix enterprises. At the end of last year, General Motors held a 26 per cent stock interest in the Bendix holding company. Whether this interest has been increased physically, we do not know. But we are quite certain that the addition of two GM executives to the Bendix set-up foreshadows some profound internal changes in the Bendix organization.

It is significant, we believe, that one of the General Motors men going into Bendix is a manufacturing executive by background, and one is a financial executive.

Ideas Wanted Now—Today

SINCE writing on this page last week a suggestion that the automobile industry purchase the Pierce-Arrow organization for the good of the industry, we have had quite a lot of favorable reaction to the suggestion from a number of people who couldn't do anything about it in a practical way, and a little from those who could.

Additional information has come in, also, on the financial condition of another company in the industry, which indicates that drastic action may soon be in order.

We iterate that the industry is becoming too small with respect to the number of interests engaged. In spite of the Sherman Act, there are probably a number of legal experiences which would ameliorate the situation. We don't pretend to have the best or the only ideas on the subject. What's yours? Now, not tomorrow, is the time when such ideas should see the light. Tomorrow may be too late!

—HERBERT HOSKING.

An Apparatus has been Developed for—

Testing Oil Filter Efficiency

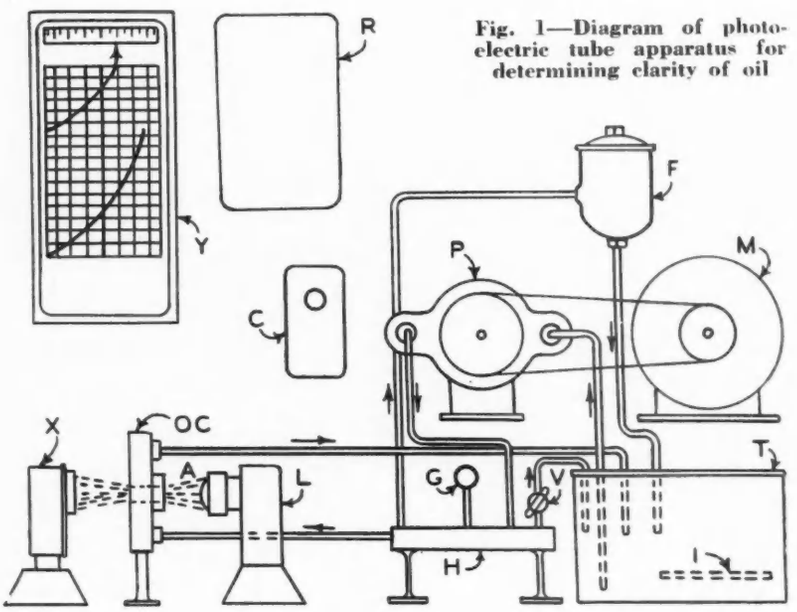


Fig. 1—Diagram of photo-electric tube apparatus for determining clarity of oil

A—Oil Film Adjustment
C—Heat Control
F—Filter
G—Pressure Gage
H—Header
I—Immersion Heater
L—Light Source
M—Motor
OC—Oil Cell
P—Pump
R—Amplifier
T—Tank
V—Pressure Regulator
X—Photo-Electric Tube
Y—Recording Milliammeter

AN apparatus for testing oil filters for efficiency has been developed by the Fleming Mfg. Co., East Providence, R. I., manufacturers of the FRAM oil and engine cleaner.

In the course of use, oil becomes contaminated with solid particles, acids, asphaltenes and oxidation products, and although the removal of the solid particles, including road dust, metal dust, abrasives, sludge and carbon, is the most important function of the oil filter, the removal of acids, asphaltenes and products of oxidation also is of considerable importance.

It has been shown by experiment that the amount of solids remaining in an oil after filtration can be determined by means of a photo-electric cell, and that the results given by the cell bear a direct relation to the precipitation number obtained when the oil is tested in a centrifuge. In applying the new method, the oil is passed through an "oil cell" through which a light ray is passed to a photo-electric tube, and the electric output of the tube is sent through a recording milliammeter, so that a permanent record is obtained of the rate of cleaning by the filter.

Fig. 1 shows the apparatus used for this test in diagrammatic form. The oil to be cleaned is in the tank *T*, from which it is forced into header *H* by the pump *P* driven by motor *M*. From the header the oil passes through the filter *F* and thence back to the bank. A ray from lamp *L* passes through the oil cell *OC* to the photo-electric tube *X*. The output of the photo-electric tube is amplified by the amplifier *R* and recorded on the card of the milliammeter *Y*. The output of the photo-electric tube varies directly with the amount of light passed by the oil cell, and this in turn varies with the amount of solid material in the oil.

In operation, a filter to be tested is installed in the apparatus at *F*, and a given quantity of oil of a known precipitation number is placed in tank *T*. The oil is heated to 150 deg. Fahr., and when this temperature is reached, pump *P* is started and the oil is pumped through the filter and the oil cell. The chart indicates the increase in the cleanliness of the oil as it is being cleaned by the filter.

When the precipitation number has been reduced to a predetermined point (approximately 0.04), or the test has run for a definite period of time, not exceeding 20 hrs., the test is stopped. Then a new batch of oil is put into the tank and the operation repeated. This is continued until the filter will not reduce the precipitation number below visual clarity (0.08) in the maximum time period allowed.

To get a direct comparison of the

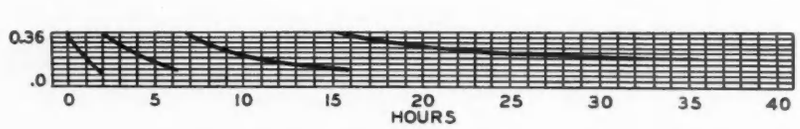


Fig. 2—Performance chart obtained from tests with photo-electric tube apparatus

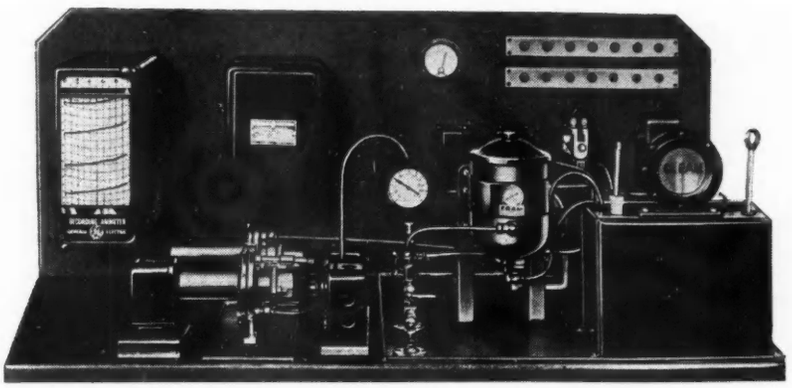


Fig. 3—FRAM oil-filter testing apparatus

precipitation number of one batch of oil to approximately 0.08, or visual clarity in 20 hours.

This method also assists in the choice of the proper size filter by determining the amount of sediment each filter will remove.

The complete apparatus is shown in Fig. 3.

efficiencies of two filters, the results of this test are charted as shown in Fig. 2. In this case the first batch of oil was reduced from 0.36 to 0.02 precipitation number in two hours. The second batch was reduced to 0.04 in four and a half hours. The third batch was reduced to 0.07 in nine hours. The fourth batch at the end of 20 hours had only been reduced to 0.18 precipitation number. The amount of oil used in each run was four quarts. From this chart it is apparent that the filter cleaned up four batches, or 16 quarts of oil, and required 35½ hours to do it.

The first batch of oil was reduced from 0.36 to 0.02 precipitation number, a reduction of 0.34; the second from 0.36 to 0.04; the third from 0.36 to 0.07, and the fourth from 0.36 to 0.18.

This is an average reduction on the four runs of 0.28 precipitation number, which multiplied by 10 gives the percentage of sediment, by volume, removed, (2.8 per cent). The total number of quarts cleaned converted to ounces (512) multiplied by this percentage gives the amount of sediment removed in fluid ounces (14.34). This represents the dirt removal capacity of the filter.

If the time factor is introduced into the calculations, the following formula is arrived at:

$$\frac{VP}{T} = \text{Efficiency Rating}$$

where

V = Total amount of oil tested, in quarts.

P = Average precipitation number removed.

T = Total time in hours.

The above test worked out by this formula is as follows:

$$\frac{16 \times 0.28}{35.5} = 0.126 \text{ Efficiency rating}$$

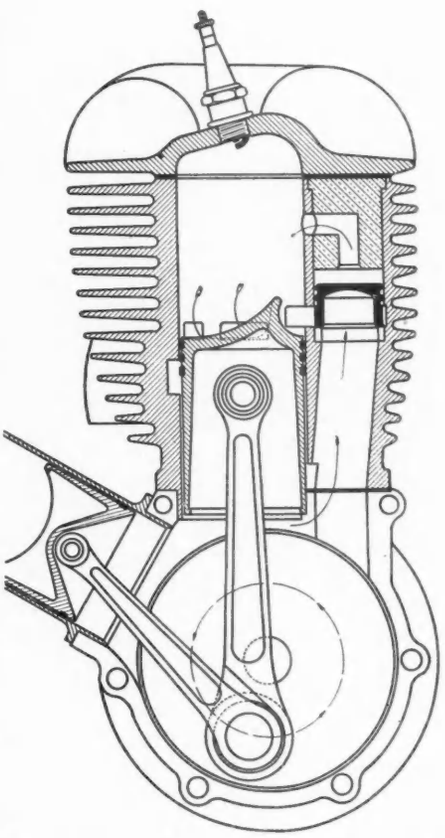
In each case the test is continued until the filter fails to reduce the

Ragoucy Two-Stroke Engine

Has Charge Transfer by Pneumatic "Shuttle"

AT present the two-stroke engine is being used only in very small units and in applications where its operating time is relatively small, so that its low fuel economy is of no great importance while its low production cost counts. The low fuel efficiency is due in part to the fact that, owing to the proximity of the inlet and exhaust ports, a part of the combustible charge admitted escapes through the exhaust ports without being burned, and in part to the fact that the presence of the ports at the bottom of the cylinder reduces the effective compression ratio, which controls the thermal efficiency.

Numerous attempts have been made to overcome this deficiency of the two-stroke engine, and one of the latest is due to M. Constant Ragoucy of Route de St. Jean, Bourgoin (Isere), France. M. Ragoucy employs a shuttle-type slide valve which is automatically operated by the pressure difference on its upper and lower surfaces and controls the transfer port into the cylinder. A sectional view of a small air-cooled engine with the Ragoucy system is shown herewith. The engine shown is arranged for crankcase precompression which is augmented by an auxiliary cylinder with piston making an angle of about 60 deg. with the working piston. In the drawing the piston in the working cylinder is shown near the end of the power stroke, exhaust having just begun. The slide valve has been forced down



Sectional view of an air-cooled engine with the Ragoucy system

by the pressure in the working cylinder (with which the space above it communicates) and closes the transfer port. However, shortly after the beginning of the exhaust period the pressure in the crankcase surpasses that in the cylinder, the slide valve is moved upward by this pressure difference, and uncovers the transfer port. It will be noticed that in this engine the transfer port is located at a higher level than the exhaust port, and charging of the cylinder therefore can continue after the exhaust ports have been closed. As the piston proceeds upward on its compression stroke, the pressure in the working cylinder surpasses that in the crankcase and the slide valve is forced down again so as to close the transfer port.

The inventor has worked out a number of different designs of his shuttle valve and the one here shown, designated by the symbol R-14, is said to have given about the best results. The shuttle is made of magnesium and weighs only between 2 and 2.5 grams per sq. cm. of its section. In the experimental engine the parts against which the shuttle abut are made of cast iron.

"Cross-Country" Motorcycle for French Army

THE Société des Moteurs Gnome & Rhone, Paris, is manufacturing in large series for the French Army a cross-country-type motorcycle that is said to be capable of running long distances in low gear without overheating and without seizing, and able to negotiate the worst terrain with full load. It has a single cylinder 3.34 by 3.46-in. engine with shielded side valves, light-alloy cylinder head, pressure-feed lubrication (twin oil pump in the crankcase, separate oil tank in the frame), unit powerplant, four gear speeds, and a clutch with asbestos facings. The first speed, which is geared very low, is said to be indispensable for cross-country work. Chain drive is fitted, and the frame, which is of pressed steel, is electrically welded, a production method that calls for large runs. The work includes rubber rings instead of springs, and it can be very easily dismounted.

The engine develops 9.5 hp. at 3600 and 10 hp. at 4000 r.p.m., measured on the main gear shaft. The horsepower curve is fairly flat, showing that there is plenty of power available at low speed, which is said to be indispensable for such a unit. The theoretical speeds at 3600 r.p.m. of the engine are 10, 25.5, 36.7 and 48.5 m.p.h. The wheelbase is 54 in. and the minimum ground clearance 7.5 in. The weight of the machine empty is 350 lb. and the fuel tank holds 4.5 gallons, which is sufficient for 210 miles.

Tin Production Reduced

THE International Tin Committee at a meeting held in London some time ago decided to cut tin production by 25 per cent during the first half of 1938. This decision was a direct result of the sharp drop in tin prices during the several weeks which preceded the date of the meeting. Of the various tin-producing countries, only Malaysia had been able to even approach the production quota allowed it, and Malaysia, therefore, is the only country which will be affected by the new restriction directly. The committee also looked into the possibility of establishing a common fund which is to act as a cushion against seasonal fluctuations in the demand for tin. However, the plan is a very vague one, and it is believed that it will meet with strong opposition from Malaysian producers.

TOOLS OF TOMORROW

(Continued from page 469)

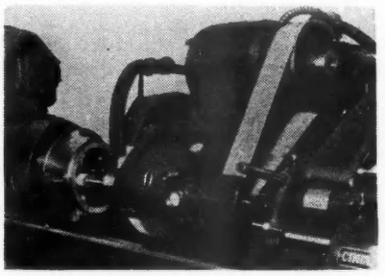
For the job mentioned, the axle is placed on two plates which are provided with locating fixtures without clamping devices. The broach is inserted from the top through the hole in the work and the face plate into an automatic puller. The broach is pulled through the work, the work is removed and the machine returns the broach, the puller releasing it at the top of the stroke.

For some classes of work, pull-down machines are said to give better coolant and chip conditions, since the coolant flows down naturally through the hole with the broach. Chips drop through into the base of the machine.

Grinding Attachment

. . . for rapid and accurate setting up is developed by Cincinnati

An internal grinding attachment, permanently fixed to the machine and hinged at the front of the grinding wheel head for rapid and accurate setting up, has been developed by Cincinnati Milling Machine and Cincinnati Grinders, Inc., Cincinnati, Ohio, for its 12 in. and 16 in. universal grinding machines.



Cincinnati internal grinding attachment

The internal attachment has a capacity ranging from 5/16-in. to 4-in. diameters, and 1½-in. to 6½-in. depths of holes, using ¼-in. to 2-in. diameter wheels depending upon the spindle chosen. Any one of seven different spindles may be specified. The speeds also depend upon the spindle chosen, varying from 10,000 to 18,000 r.p.m.

Milling Cutters

. . . Ex-Cell-O develops new standard line of tungsten carbide tipped cutters

With a view toward lowering replacement blade costs on tungsten carbide tipped milling cutters, Ex-Cell-O Corp., Detroit, in cooperation with the Carboloy Co., has developed a new standard line of tungsten carbide milling cutters.

The new Ex-Cell-O milling cutters incorporate the Continental Type "RC" blade lock. In this construction, tapered blades fit into accurate tapered seats, blade supports being integral with the cutter body. Blades may be adjusted individually any desired amount, according to the grinding time necessary on each blade. Further, this type of blade lock is said to facilitate set-up or changing of blades, since blades are locked in place in pairs with an external clamp requiring only a turn of an Allen wrench to either tighten or ease the clamp. A light tap then releases any individual blade from the cutter body.

Other advantages of this type of construction as pointed out by the manufacturer include the assurance of maximum heat conductivity through the provision of accurately fitting full-face blade seats, and security of blade lock without need for end stops.

Goodyear's Litchfield "Optimistic"

Company's President Sees Increase in Renewal Sales and Continued Growth in Sales of Tires for Tractors and Farm Implements

Optimism about certain phases of the outlook for the rubber industry in 1938 was expressed by Paul W. Litchfield, Goodyear president, at the annual stockholders' meeting March 28.

On decentralization, Mr. Litchfield asserted that it will diminish provided adjustments are made in the Akron wage rates, coupled with the return of improved efficiency.

Hourly and piece workers for Goodyear in the United States numbered 18,269 persons, including both male and female help, skilled workers as well as common laborers, janitors and so forth, he said.

"Before the average worker could be given a job, our security-holders had to invest $6,500 in the company with which to provide him with machinery and tools and that part of the factory building in which he is to work.

"The goods produced by this average worker last year were sold for $10,000. Of this total amount $8,100 went to repay advances made by the company to buy the raw materials used by the worker, pay for the services of the other employes needed to help him carry on and meet such current expenses as taxes, freight, advertising, heat, light, etc.

"Approximately $1,500 went to the worker, whether skilled or unskilled, in wages, leaving a balance of about $400 for the company's earned surplus account to pay dividends and interest.

"The value of such a picture is that it lends perspective to a consideration of the average factory worker who, while he alone represents "labor" in the current public consciousness, finds that his own services take on economic value only when applied to the operation of modern tools and machinery in conjunction with many other types of workers who not only provide the necessary raw material but dispose of the finished product when it is ready for the market," he said.

"There must be adequate protection for the interests of the nonfactory employes of the same industry as well as the interests of the stockholders and consumers," he added.

He reviewed the current recession and its application to labor relations and said that approximately 5000 Akron employes had been laid off and the remainder, particularly in the tire division, had been placed on short time.

Renewal tire sales, "which apparently hit bottom in 1935," should show encouraging gains in 1938, based on the fact that there are approximately 29,650,000 registered motor vehicles, wearing out tires and requiring the substitution of new ones, he said.

The volume of sales to automobile manufacturers will be substantially lower, he said, but added that sales of pneumatic tires for tractors and farm implements likely will continue their growth.

Logan Thomas Wood

Logan Thomas Wood, vice-president and general manager of Gar Wood Industries, Inc., died of pneumonia in San Francisco, March 27.

Automotive Metal Markets

Steel Market Anticipates Continued Improvement of Ingot Rate With Larger Volume of Automotive Business in April

While disappointment that buying by automobile manufacturers is not making a better showing is made much of in the steel market, it is obvious that automotive consumption, relatively light as it is, still furnishes much of the support that in March permitted the steel industry to step up primary operations from around 30 per cent to more than 35 per cent of ingot capacity. A good deal of what is classified as miscellaneous demand is made up of small lot buying by suppliers of automobile manufacturers. What the steel industry painfully misses are tonnage orders from the large automobile manufacturers, but routine small lot buying is still in the aggregate far from a negligible factor in the steel market.

Finishing mills reported a small volume of rush orders that had to be shipped before higher freight rates went into effect. On some roads Monday was the dead-line, while on others higher pig iron freight rates will not become effective until next week. Sentiment in the steel market continues hopeful, somewhat more so among producers with a nest-egg of automotive business on their books than those not so fortunate, but on the whole the steel industry is confident that further progress on the road toward a more satisfying volume of automotive demand will be registered in April, and that paucity of stocks in consumers' hands will be the cardinal factor in this betterment.

The non-ferrous metal markets were more or less under the spell of Wall Street this week. From Singapore comes word that Sir John Bagnall, chairman of the Straits Trading Co.'s directorate and an avowed opponent of tin market control, has urged the Federated Malay States government to withdraw from the International Agreement. Sir John is against the buffer pool project. The International Tin Committee, which was to have met next Tuesday to consider the buffer stock plan, is reported to have postponed its session. Meanwhile the tin market marked time. The week's opening price for spot Straits was 40.90 cents. On Tuesday spot tin was offered at 40½ cents, with buyers hugging the sidelines.

Copper showed a fairly steady tone, producers and custom smelters maintaining their price for electrolytic at 10 cents. In the outside market, the ruling quotation was 9¾ cents. Producers' fabricating subsidiaries were taking copper in 1000-ton lots at frequent intervals. Export business was reported active, Japan and Russia being the chief buyers. The price range was 9⅝ to 9¾ cents. Secondary refiners lowered their scrap buying quotations by ⅛ cent.

In announcing that $14,000,000 additional to previous appropriations would be expended in developing production facilities, the leading producer of nickel emphasized that nickel is primarily a peace-time metal, and that, contrary to popular notions, not more than 10 per cent of the output went into armaments and ammunitions, even when war preparations register fever heat.

Lead showed a steady, but quiet tone all week.—W. C. H.

Letters

to AUTOMOTIVE INDUSTRIES

Editor, AUTOMOTIVE INDUSTRIES:

I note in the Feb. 19 issue of AUTOMOTIVE INDUSTRIES under "Just Among Ourselves" that you call attention to the 1938 Consumer's Research Bulletin rating current automobiles. Yesterday, I received a copy of the rival organization's automobile bulletin (Consumer's Union of U. S.). I found both of them interesting, and considering their meager finances, they have done a surprisingly good job. Knowing that there is no love lost between the two rival organizations, and hence almost certainly no collusion in arriving at ratings, I sat down last night to compare the two ratings. The results are interesting and surprising.

Omitting the models not appearing in both lists, I copied both lists in order given and compared rankings. The results were as follows:

Out of 37 models appearing in both lists the rank order was: Exactly the same in 14 cases, differed by one rank in 16, differed by 2 ranks in 1, differed by 3 ranks in 4, differed by 4 ranks in 2, differed by more than 4 in no cases.

Calculating the correlation between the two ranks gave the very high figure of plus 0.90.

This high degree of correlation between two independent sets of raters is interesting to say the least. What the moral is I don't know. Nor do I know just how much effect the ratings of these two organizations has on consumer preference in purchasing automobiles, but I have discovered that salesmen do know what they both say, particularly if their car gets a good rating.

S. E. T. L.

Expect No Tire Price Cut

Despite the fact that crude rubber March 29 sagged to its lowest price level since 1931, breaking under 12 cents per pound on the New York market, Akron manufacturers say there is little, if any, likelihood of a tire price reduction. They point to the fact that the cost of rubber going into tires trails the market price by from 90 to 120 days. With production already picking up and destined to be materially increased during April they anticipate that renewed crude rubber buying activity will stiffen prices.

The market break was the reaction of the decision of the International Rubber Regulations Committee in Londay March 29 to not change basic quotas. The crude rubber quota under previous decision drops April 1 from 70 per cent to 60 per cent. The committee's next meeting is May 31, indicating that it does not view the market situation with alarm.

Manufacturers point to the fact that consumer tire buying in the first quarter ran considerably ahead of dealer buying, meaning a substantial liquidation of dealer stocks. With the spring consumer buying rush now starting, dealers will be compelled to reorder heavily during April and May. It is estimated that total replacement sales in the first quarter of 1938 were over 5,000,000 casings.

Calendar of Coming Events

Conventions and Meetings

Midwest Power Conference, Sponsored by Armour Institute of Technology, Chicago, April 13-15

SAE National Tractor Meeting, Milwaukee, Wis. . . . . April 14-15

Greater New York Safety Council, Inc., Ninth Annual Convention, New York City, April 19-21

Chamber of Commerce Meeting, Washington . . . . . May 2 to 5

American Foundrymen's Association, Foundry Show, Cleveland . . . . . May 14-19

National Battery Manufacturers' Association, Spring Convention, Cleveland . . . . May 24-25

SAE Summer Meeting, White Sulphur Springs, W. Va., June 12-17

Eyston's Thunderbolt Sets New World's Record on Paper First

(*Continued from page* 481)

tirely satisfactory, as the resistance of the air was reduced to 2/3 that of the original English design. The power balance was as follows:

	311 m.p.h.	342 m.p.h.
Rolling resistance .	135/1000 lb.	210/1000 lb.
Total rolling resistance	2079 lb.	3234 lb.
Total air resistance	880 lb.	1056 lb.
Grand total	2959 lb.	4290 lb.
Power at rims	2500 hp.	3970 hp.

The maximum power available being 3400 hp., the maximum possible speed would lie between 330 and 333 m.p.h. At 311 m.p.h. the vehicle still had a reserve of 900 hp. at the rims. At 301 m.p.h., the old record, there were still 1300 hp. in reserve. At 319 m.p.h., the maximum speed attained, there were still 650 hp. unused.

Before leaving for the United States, Eyston said he would not exceed 310 m.p.h very much, as he wanted to leave competitors a chance. It is also possible that he preferred not to push his engines to the limit because of the trouble he had had with his clutches.

The figures given in the power-balance table call for some remarks. It will be seen that the rolling resistance increases rapidly with the speed, and is, in fact, the principal limiting factor. At 310 m.p.h. it is twice as great as the air resistance, and at 342 m.p.h. it is three times as great—with an inflation pressure of 100 lb. per sq. in. and wheels of 43 in. diameter.

Assuring Stability

Aerodynamic Stability — M. Andreau said he found it impossible to give the body a zero angle of incidence, because the form of the chassis did not permit of it. However, the actual angle of incidence is only 3 deg., and the resulting force is negligible in comparison with the weight, even at 342 m.p.h. In this connection it is interesting to recall that Campbell was obliged to carry 300 lb. of ballast at the rear of his vehicle at 250 m.p.h. A teammate of Rosemeyer recently had his car turn end for end at 250 m.p.h. when fitted with a new body. This was caused by loss of adherence due to the fact that the angle of incidence was not zero; in other words, the car was lifted by the air pressure under it. The papers did not give any details. It may have been the front end which left the ground. One thing is certain, and that is that a vehicle which has no downward pressure component is unstable.

In the same measure as the resistance coefficient diminishes, the horizontal instability increases, because the meta center moves forward farther and farther. In the Thunderbolt it required considerable effort to bring it back slightly behind the center of gravity. Its location was determined by calculation. The Thunderbolt is provided with fins like an arrow and is inherently stable. This was proved by Eyston, moreover, who, while driving at 318 m.p.h. had to reach for his goggles, which were coming off, and while doing so drove with one hand without trouble. In contrast to this, Sir Malcolm Campbell complained of fatigue at the end of two runs over the trial course, due to the instability of his vehicle, which, moreover, was one of the factors that decided him against renewing his attempt. M. Andreau remarks in this connection that he had

considerable difficulty in convincing Captain Eyston that he needed a downward pressure component.

Cooling System Changed

Cooling of the engine was a difficult problem. The car necessarily must be brought up to speed before the record run is started, and by that time the temperature of the cooling water is 140 deg. Fahr. At the altitude of the salt beds, water boils at 176 deg., and there is, therefore, not much reserve. Moreover, the power developed is enormous, and the heat thrown into the cooling system is proportionately large. The original project called for a water tank of 100 gallons, the heat capacity of which would keep it slightly below 176 deg. during the record trial. The idea was not to add to the air resistance by employing a radiator. While investigating the possibility of lightening the vehicle, Mr. Andreau calculated a cellular-type radiator made up of $\frac{3}{8}$-in. tubes, with a height of 16 in. and a frontal area of 4.3 sq. ft., placed partly in an N.A.C.A. cowling, with outlets at top and bottom in regions of minimum-pressure, which latter were determined by calculation. In this way the weight was reduced 660 lb., and with the cowling used the air-resistance coefficient was not materially increased. It seems to have given satisfaction. At a speed of 311 m.p.h. the velocity of the air relative the radiator is 462 m.p.h.

In making the record run it is necessary to start, accelerate and reach the maximum speed ahead of the starting line, and after the official course has been covered it is necessary to bring to a stop a mass of 7 tons from a speed of over 300 m.p.h., in a rather limited distance. Braking is out of the question, because the rubber tread of the tires is only 0.040 in. thick and would not resist the stresses, except, perhaps, at less than 125 m.p.h. Acceleration is a question of the proportional weight on the drivers and of the coefficient of adherence. In the calculations, a coefficient of adherence of 0.5 was assumed, and it was shown that with this it was just barely possible to attain the maximum speed ahead of the starting line. This fact seems to be confirmed by Captain Eyston's proposal to add two driving wheels at the front, to improve the acceleration. In order to bring the car to a stop in the available distance, two vanes were provided at the rear, between the wheels and the sloping tail. These vanes were pivoted on vertical axes and expanded outward from the axis of the vehicle. They are provided with hydraulic control. Their surface area is 13.72 sq. ft., and their coefficient of air resistance, 0.00287. When unfolded, they multiply the air resistance of the vehicle in the proportion of 5.35 to 1.

At 330 m.p.h. the air resistance is then 5280 lb. and the rolling resistance 2816 lb., which makes the total 8096 lb. and gives a deceleration equal to 0.525 times that of gravity. By applying deceleration formula it is found that under these conditions it takes 2.2 miles to come down from 311 to 125 m.p.h. Below this speed the use of the brakes is permissible. If by a mischance only one of the vanes should open at 300 m.p.h., it would not throw the vehicle out of balance, because its moment around the vertical axis through the center of gravity would be small compared to that of the adherence. The arrangement seems to have worked out quite satisfactorily.—*Journal of the French Society of Automobile Engineers* for January.

GM Diesel Plant

(*Continued from page* 479)

two long holes by indexing twice from the top surface and then reaming in two operations from the bottom. In every case, positive and precise alignment is assured, since the piece remains in the same fixture and in its original setting until the work is completed.

Another big problem is the drilling of spray nozzle holes. They are tiny, as holes go, but in addition to accurate sizing the holes must be drilled at correct angles with precise spacing. These holes are of various diameters, depending upon the size of the engine, the general range lying between six-thousandths and fourteen-thousandths of an inch in diameter. Drilling is done by means of a tiny air-operated turbine. The fine jeweler's drills are so sensitive to pressure that they cannot be fed into the work by mechanical means. So the drill spindle floats and is pressed into the work by the operator's finger as the drill rotates.

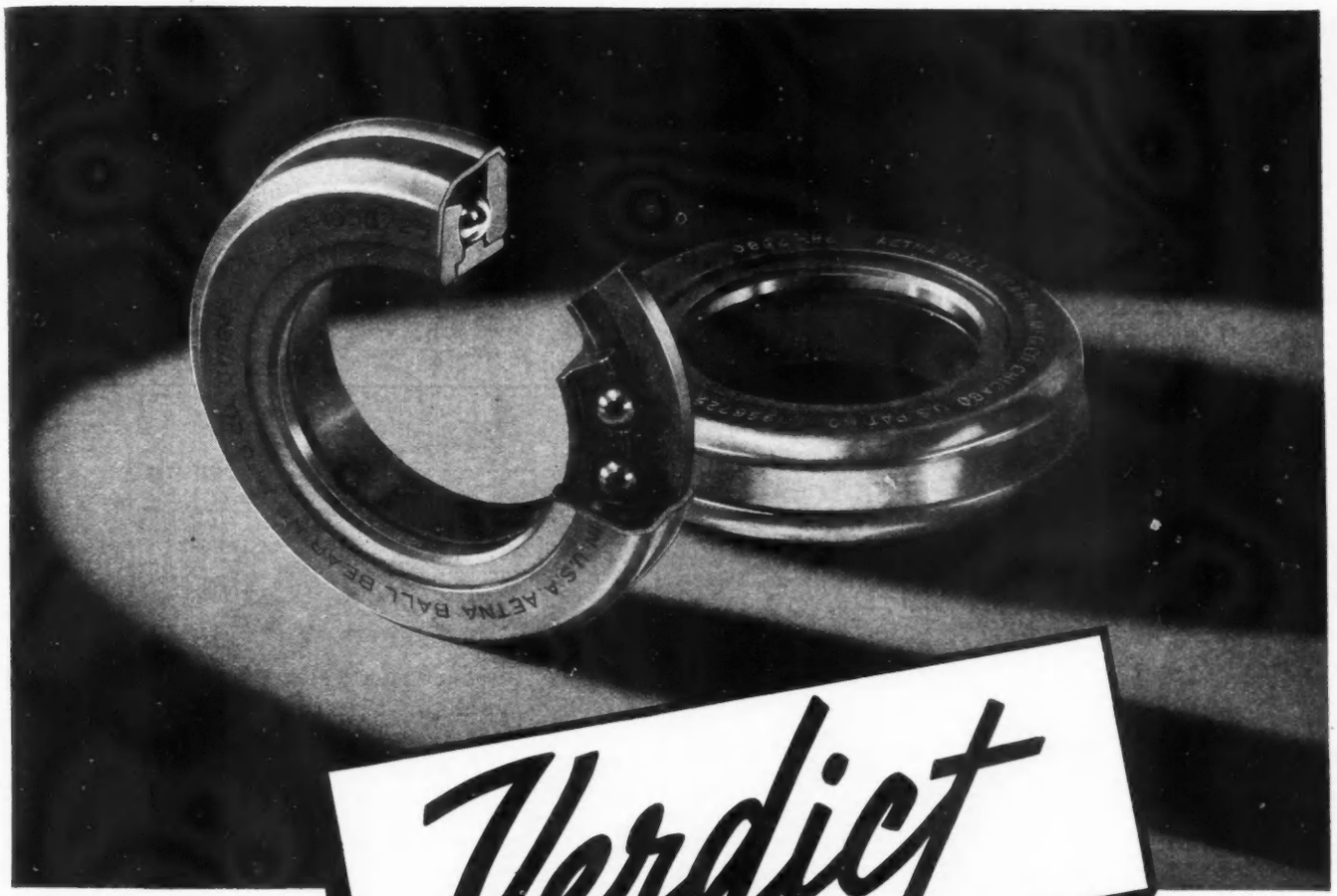
All of the internal parts and bushings are lapped to provide the desired finish and polish. While this is a hand operation, it is facilitated by the development of a battery of special lapping machines both for internal and external parts.

In another section of this department will be found the assembly line for the small engine injectors, as well as benches for assembly of large units. Before leaving this department, each injector is tested first on a machine which tests its seal under pressure of 5,000 pounds per square inch, then on another machine that "pops" the nozzle to assure clear passages.

The final step is the test department, in which each injector is tested individually and calibrated according to specifications. Here will be found a testing machine with a universal fixture for handling all types of injectors; two other test machines for large injectors; and two multiple-head testing machines for small injectors. The latter tests ten injectors in each machine. The entire battery is served by a central unit which circulates filtered oil and lubricant to all machines.

It is interesting to note that the calibration of injectors involves precise laboratory measurement. In the first place, each machine has an accurate device for counting the number of strokes of the injector plunger. When the injector is tested, it is run for a certain length of time, and during that interval the fuel oil that it ejects is collected in a laboratory graduate glass. When the test run is stopped, a reading is taken of the number of plunger strokes, and this number is divided into the volume of oil collected in the graduate. The quotient represents the number of cubic millimeters of fuel per stroke—which must be right "on the nose" with the specification or the injector is rejected.

Finally, it is well worth knowing that all precision grinding operations on injector elements are performed in a centralized grinding department, located in the precision machining department, but completely isolated from it. This is done for two reasons. First, it keeps the precision grinding department clean and free of any dust or dirt; second, it protects the precise drilling and lapping operations in the other department from the fine dust and grit that may originate from the grinding wheels.



ANY product that wins year after year preference among users as value-wise as automotive engineers MUST be unusual. Aetna "T" Type Clutch Release Bearings ARE unusual. Aetna's have patented, practical features different from all other clutch release bearings. They are the only clutch release bearings with one-piece, "T" shaped bronze impregnated ball retainers that guarantee permanently true raceway alignment and thus abolish eccentric thrust and its counterparts, noise, wear, costly repair bills and early doom. And Aetna's are the only clutch release bearings offering permanent, positive, escape-proof lubrication. They are not only efficiently sealed but designed with beveled ring and shell surfaces that force centrifugally thrown lubricant back to the vital working parts. There's no chance for lubricant to escape to clutch facings, no need of installing grease fittings, no further maintenance whatsoever. So, if you want a release bearing you can install in the clutch position and forget for the life of your cars and trucks, specify Aetna's. Your verdict, too, will be enthusiastic. AETNA BALL BEARING MANUFACTURING COMPANY, 4608 SCHUBERT AVE., CHICAGO, ILLINOIS. DETROIT OFFICE—7310 WOODWARD AVE.

Aetna "T" Type — THE "T" TAMES TROUBLE

GM Diesel Plant

(*Continued from page* 479)

two long holes by indexing twice from the top surface and then reaming in two operations from the bottom. In every case, positive and precise alignment is assured, since the piece remains in the same fixture and in its original setting until the work is completed.

Another big problem is the drilling of spray nozzle holes. They are tiny, as holes go, but in addition to accurate sizing the holes must be drilled at correct angles with precise spacing. These holes are of various diameters, depending upon the size of the engine, the general range lying between six-thousandths and fourteen-thousandths of an inch in diameter. Drilling is done by means of a tiny air-operated turbine. The fine jeweler's drills are so sensitive to pressure that they cannot be fed into the work by mechanical means. So the drill spindle floats and is pressed into the work by the operator's finger as the drill rotates.

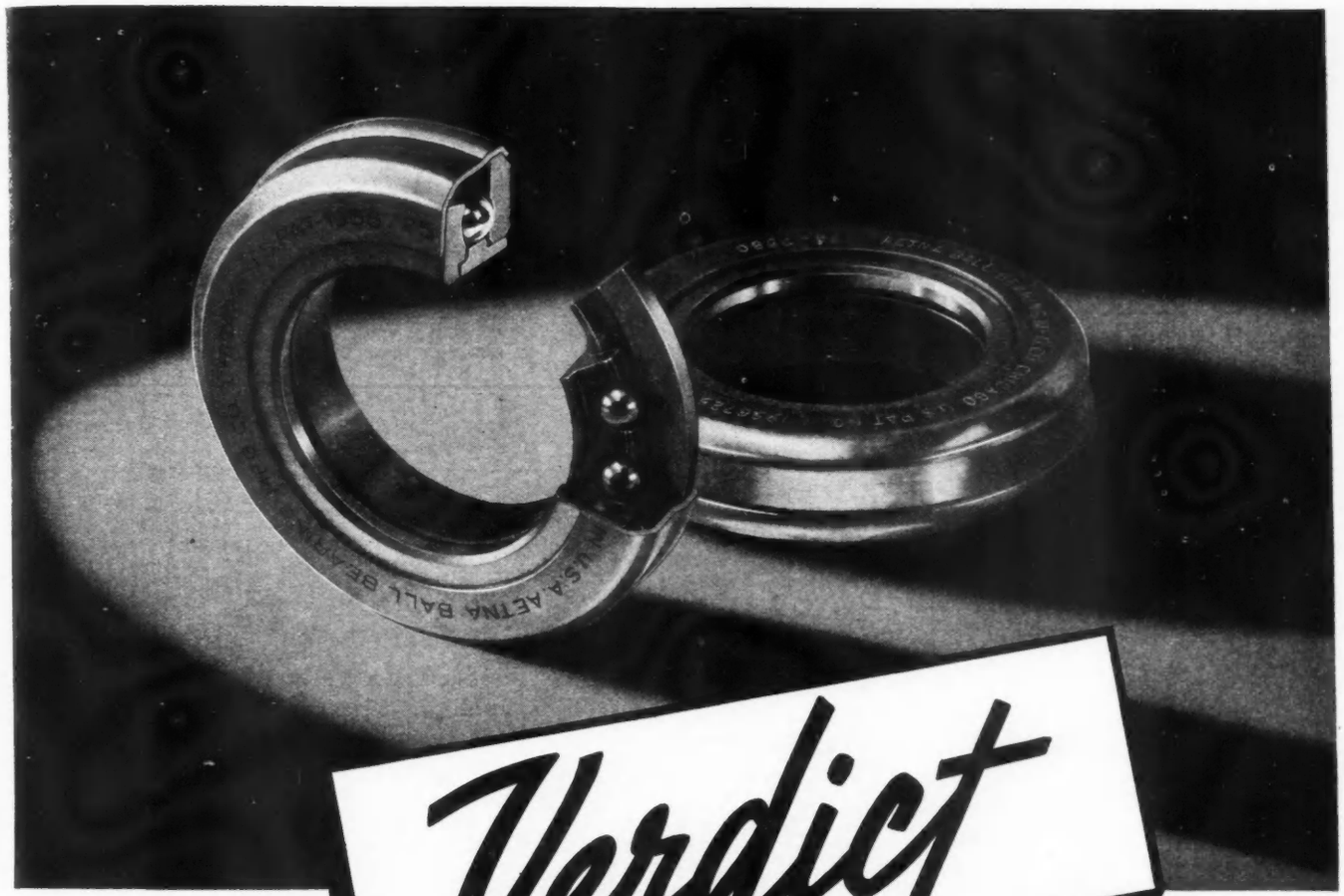
All of the internal parts and bushings are lapped to provide the desired finish and polish. While this is a hand operation, it is facilitated by the development of a battery of special lapping machines both for internal and external parts.

In another section of this department will be found the assembly line for the small engine injectors, as well as benches for assembly of large units. Before leaving this department, each injector is tested first on a machine which tests its seal under pressure of 5,000 pounds per square inch, then on another machine that "pops" the nozzle to assure clear passages.

The final step is the test department, in which each injector is tested individually and calibrated according to specifications. Here will be found a testing machine with a universal fixture for handling all types of injectors; two other test machines for large injectors; and two multiple-head testing machines for small injectors. The latter tests ten injectors in each machine. The entire battery is served by a central unit which circulates filtered oil and lubricant to all machines.

It is interesting to note that the calibration of injectors involves precise laboratory measurement. In the first place, each machine has an accurate device for counting the number of strokes of the injector plunger. When the injector is tested, it is run for a certain length of time, and during that interval the fuel oil that it ejects is collected in a laboratory graduate glass. When the test run is stopped, a reading is taken of the number of plunger strokes, and this number is divided into the volume of oil collected in the graduate. The quotient represents the number of cubic millimeters of fuel per stroke—which must be right "on the nose" with the specification or the injector is rejected.

Finally, it is well worth knowing that all precision grinding operations on injector elements are performed in a centralized grinding department, located in the precision machining department, but completely isolated from it. This is done for two reasons. First, it keeps the precision grinding department clean and free of any dust or dirt; second, it protects the precise drilling and lapping operations in the other department from the fine dust and grit that may originate from the grinding wheels.



Verdict

ANY product that wins year after year preference among users as value-wise as automotive engineers MUST be unusual. Aetna "T" Type Clutch Release Bearings ARE unusual. Aetna's have patented, practical features different from all other clutch release bearings. They are the only clutch release bearings with one-piece, "T" shaped bronze impregnated ball retainers that guarantee permanently true raceway alignment and thus abolish eccentric thrust and its counterparts, noise, wear, costly repair bills and early doom. And Aetna's are the only clutch release bearings offering permanent, positive, escape-proof lubrication. They are not only efficiently sealed but designed with beveled ring and shell surfaces that force centrifugally thrown lubricant back to the vital working parts. There's no chance for lubricant to escape to clutch facings, no need of installing grease fittings, no further maintenance whatsoever. So, if you want a release bearing you can install in the clutch position and forget for the life of your cars and trucks, specify Aetna's. Your verdict, too, will be enthusiastic. AETNA BALL BEARING MANUFACTURING COMPANY, 4608 SCHUBERT AVE., CHICAGO, ILLINOIS. DETROIT OFFICE—7310 WOODWARD AVE.

Aetna "T" Type CLUTCH RELEASE BEARINGS

THE "T" TAMES TROUBLE